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METEOROLOGY OF AUSTRALIA.
COMMONWEALTH BUREAU OF METEOROLOGY,
MELBOURNE.

THE CLIMATIC CONTROL OF AUSTRALIAN PRODUCTION

(AN ATTEMPT TO GAUGE THE POTENTIAL WEALTH OF THE COMMONWEALTH).

BY

GRIFFITH TAYLOR, B.Sc., B.E. (SYD.); B.A. (CAMB.); F.G.S., F.R.G.S.
(PHYSIOGRAPHER, COMMONWEALTH METEOROLOGICAL BUREAU, MELBOURNE.)

BULLETIN No. 11.

Published under instructions from The Honorable King O'Malley, M.P., Minister of State for Home Affairs.

H. A. HUNT
COMMONWEALTH METEOROLOGIST.

Printed and Published for the Government of the Commonwealth of Australia by Albert J. Mullett,
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THE CLIMATIC CONTROL OF AUSTRALIAN PRODUCTION

(AN ATTEMPT TO GAUGE THE POTENTIAL WEALTH OF THE COMMONWEALTH).

BY

Griffith Taylor, B.Sc., B.E. (Syd.); B.A. (Camb.); F.G.S., F.R.G.S.

I.—INTRODUCTION.

1. Previous Work.

For many years the lack of a uniform presentation of the distribution of Australian products has been felt. In 1908, I made an investigation of the potentialities of Australia, based on a study of the geology and of the rainfall of Australia, which was published in 1911.*

Many Government maps have been published by the various States dealing with one or other of the products under discussion. Geology and mining have been well represented. The cognate data for rainfall are now complete, but the agricultural and pastoral assets have been very scantily treated cartographically, and quite different methods have been used in the different States.

In 1912, the advisability of a Federal Atlas was considered, and a Committee appointed to deal with the matter. Similar official publications have been published in most other civilized countries, notably in the United States of America and in Sweden. I was appointed editor of this work, but its publication has, unfortunately, been indefinitely postponed in consequence of the war.

There is no prospect at present of a complete presentation of our national assets, but the present memoir is an attempt to correlate the vital factor of *climate* with the three products, *cattle, sheep,* and *wheat.*

2. Scope of the Work.

The thirteen principal products during 1913 were approximately as follows :—

Sheep and Cattle.		Mining.		Wheat.		Others.	
Wool	26	Gold	10½	Wheat	13	Timber	1
Butter	9	Coal	4				
Frozen Meat ..	3	Silver-Lead ..	3				
Tallow	2	Copper	2½				
Sheep Skins ..	1½	Tin	1				
Hides	½						
Total ..	42		21		13		1

(Figures represent millions sterling.)

As already stated, there are numerous maps and records relating to the mineral products, though here also there are few accounts dealing with the Commonwealth as a whole.† Apart from them all the other important commodities, except timber, are derived from sheep, cattle, and wheat. For this reason I have confined my attention to these three.

---

* *Australia in its Physiographic and Economic Aspects, Oxford at the Clarendon Press,* 1911 (Revised Edition, 1915).

† See Chapter VI. in Vol. V. of the *Oxford Survey of the Empire,* 1914, *Australian Mining,* by Griffith Taylor, with seventeen maps.

The year chosen for consideration was 1912. This was more convenient than 1913, in that statistics were more readily obtained, while data are not yet complete for later years. The general climatic history of the last seven years should be noted; the years 1908, 1909, and 1910 were favoured with good rainfall on the whole; 1911, 1912, and 1913 were rather dry; while 1914 was extremely dry, and was the worst drought year on record in a large part of South Australia, in Western Victoria, and the Riverina. Thus, the year 1912, for which these maps have been drawn, is an average year so far as the last eight or nine years are concerned. The average rainfall map for the whole of Australia, based on many years' records, is shown in Fig. 1.

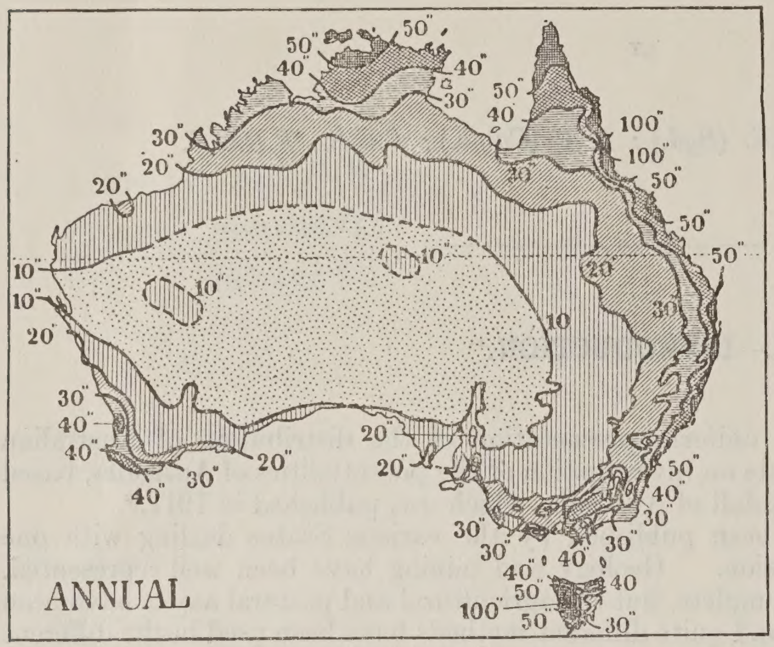


Fig. 1.—Average Annual Rainfall in Australia.

In 1912, about 12 per cent. of the continent had rain in excess of normal, chiefly along the north-west coast near Derby and in a belt from the Gawler Ranges to Kosciusko (see Fig. 2). A more northern belt from Onslow (Western Australia) across Australia to South-west Queensland was very dry. In the wheat areas the harvest results were much better than had been anticipated from the low rainfall of the earlier part of the year.

3. Authorities Consulted.

The actual figures used consist in all cases of *numbers per square mile.* This is in agreement with geographical practice elsewhere, and is employed in the U.S.A. atlas quoted above. The statistics for the various States were usually given in acres, so that considerable preliminary conversion was necessary before the calculation per unit area could be commenced. It is hoped that resulting errors are few.

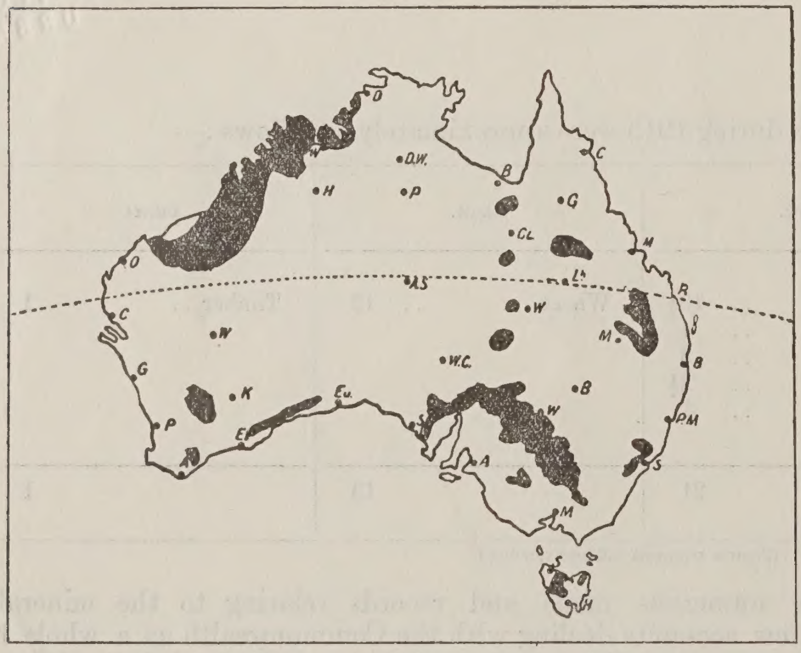


Fig 2.—Rainfall 1912, showing Areas (12%) above average.

The utmost diversity obtained in the presentation of data by the statisticians. Western Australia was found to be the easiest to consult, for a map was given with the data tabulated on a uniform *graticule.* In South Australia the basis was the *county* for the settled regions, while for the northern portion of the State the cattle and sheep could only be referred to various indefinite areas. In Victoria *counties* were used and also in New South Wales. In the latter State several of the larger counties were split into two or three sections by the boundaries of the major land districts, which complicated matters. In Tasmania *municipal* or petty session districts were used, and the Statist kindly furnished me with a map of these districts and with the areas in each. In Queensland, similar *districts* were used—but I was informed that as they were often changed, their boundaries and areas were not known exactly. I had, therefore, to make use of a 1910 map, prepared by the Immigration Bureau, as explained later. For Northern Territory, the External

Affairs Department kindly supplied a list of *localities* and the number of cattle and sheep reared in the vicinity of the same. It was thus possible to obtain a rough idea of the distribution in that large tract of the continent, where no land districts are yet defined.

As regards rainfall data : The maps and the figures of the Weather Bureau have been used —especially the valuable series of maps showing the rain falling in the several States during the months of wheat culture. The topographic data for New South Wales, Victoria, and Western Australia are already used as a basis of our rain maps. South Australia is almost ready, and approximate topographic maps of other States are in preparation. This question is more fully discussed in, and numerous maps are being prepared for, a companion Bulletin, *Characteristics of Australian Rainfall,* which will be published shortly.

I have made free use of Mr. Knibbs' authoritative *Year-Book.*

4. The Physical Controls.

As regards the three commodities under discussion (cattle, sheep, and wheat), the chief control is undoubtedly that of rainfall. This affects absolutely the distribution of wheat, and notably the distribution of cattle and sheep. However, although it is true that no cattle or sheep are found in the desert portion of Australia, yet the flocks and herds range from regions with 60-inch rainfall to those with 6 inches, implying a considerable range of adaptability on the part of the animals concerned. Yet as regards the more important sheep and cattle districts, the rainfall will be shown to define fairly accurately those areas where the pastoral industry seems to flourish best. Moreover, the same isohyets do not affect sheep and cattle equally, and this is another point which will be demonstrated in the maps.

The temperature factor is very important in two of the industries. While cattle are almost ubiquitous and thrive even in the far north and far west, the hot country—or, perhaps, more exactly, the tropical vegetation—does not appear to suit sheep so well as do the conditions in the cooler and drier regions to the south. The northern limits of the wheat belts are undoubtedly controlled by the increase of temperature. A special study of this aspect of the problem is included, in which similar regions in U.S.A. and in India are described, in the hope that some new climatological evidence in favour of the northward extension of the wheat belt is put forward.

The topographic control (with which is linked up that of accessibility) is briefly discussed in the sections on the various States, but other important factors in agriculture, such as soils, noxious weeds and pests, endemic diseases, &c., are obviously out of place in this memoir, and are ignored.

II.—WESTERN AUSTRALIA.

5. Climate.

The average temperature of this State ranges from 85 degrees at Wyndham to 60 degrees near Albany, the isotherms running more or less parallel to the north-west coast. As regards rainfall, there are three regions. The northern or *tropical division* has a summer rainfall of 30 inches in the north and 10 inches in the south. The *arid region,* including most of the State south of the tropic (except the area lying south-west of a line joining Shark Bay to Eyre), has an average rainfall of less than 10 inches per year. The western portion of this arid region seems, however, to have a very variable rainfall, and as far inland as Wiluna adjoining stations vary from 8 to 11 inches per year. The south-west* of the State ("Swanland") is different in character from any other portion of Australia. Its rains fall chiefly in winter, and reach 40 inches per annum near Cape Leeuwin, which differentiates it from the rest of the State; while its geology and flora are notably different from that of the winter rain regions in Eastern Australia.

The topographic factor is not of much importance in Western Australia. The highest land lies between the Fortescue and Ashburton Ranges, where Mount Bruce reaches 4,024 feet. Perhaps in North Kimberley is found the only region where the rugged nature of the country has hindered effective settlement. Elsewhere the State forms part of the great Western Plateau (or Peneplain) of about 1,500 feet elevation. This is somewhat abruptly truncated by the Darling Scarp in the south-west, but extends uninterruptedly over the whole of the interior.

---

* For this geographic entity—the well-watered region in the south-west of Western Australia—a comprehensive name akin to Gippsland, New England, &c., is badly needed. A euphonious name connoting the chief river, the most characteristic animal, and the national emblem would be "Swanland."

6. Cattle in Western Australia. (See Fig. 4.)

In 1912 there were 806,294 cattle in Western Australia, and the State contained about 7 per cent. of Australian cattle. It was fourth on the list, being excelled by Queensland, New South Wales, and Victoria.

Compared with other States, the only important cattle country is that at the head of the Fitzroy River, where a large tract carries eleven to the square mile. The Ord River, in the extreme north, is also an important cattle region. These districts are reached *viâ* Derby and Wyndham respectively.

South of Kimberley there is another less important centre near Nullagine, with four to the square mile. This is chiefly served by Port Hedland. All the rest of the State has less than one animal to the square mile, except around Peak Hill and the dairy region from Gingin southward.

The arid inland region where no cattle are reared forms a rectangular area enclosed approximately between latitude 20° and the south coast and longitudes 123° and 129°. The western boundary varies according to the presence of railways, bulging inland near Laverton and towards the coast at the inaccessible regions east of Mount Bruce.

RAINFALL CONTROL.

It is clear that the heavier rainfall and warmer conditions of the Kimberley region are best suited for the rearing of beef cattle. The 20-inch isohyet near latitude 20° separates the northern cattle country from the drier and less important areas to the south.

Accessibility to the closely settled regions of what I have termed "Swanland" is the factor controlling the dairy country in the south-west. This lies wholly between the 20-inch isohyet and the sea.

FUTURE PROSPECTS.

Using as a standard of comparison the time since the cattle of the State were half their number in 1912, we find that this is 12 years in Western Australia, 32 in Northern Territory, 34 in Queensland, 52 in Victoria, and longer in the other States. Hence, cattle are increasing in numbers much more rapidly in the western State than in the others.

The fact that cattle apparently thrive near Nullagine and Peak Hill, with a hot climate and rainfalls of only 12 inches and 9 inches respectively, seems to imply that all the region from Kimberley southward as far as "Swanland" should ultimately support cattle. For these two centres have no climatic advantages over any other portion of the huge area lying west of longitude 121°.

The area above-mentioned is approximately 800 miles by 300 miles, or 240,000 square miles, and it should support three or four cattle to the square mile, judging by the capacity of similar regions. Thus, another 800,000 cattle may be expected in Western Australia within the next twenty years.

As communication becomes freer, there is no doubt that the carrying capacity will become greater, though it seems unlikely that Western Australia will ever rival Queensland as the chief cattle State.

7. Sheep in Western Australia. (See Fig. 3.)

There were 4,596,958 sheep in the State in 1912, Western Australia being the fifth State in importance in this respect. Here again its rate of increase is, however, the greatest. Using the same standard as in the preceding section, it is seen that Western Australia has doubled its sheep in 24 years. The growth in Western Australia has been steady, whereas in Queensland and other States the numbers have changed very little since 1890. Indeed, in the latter year there were more sheep in Australia than in 1912.

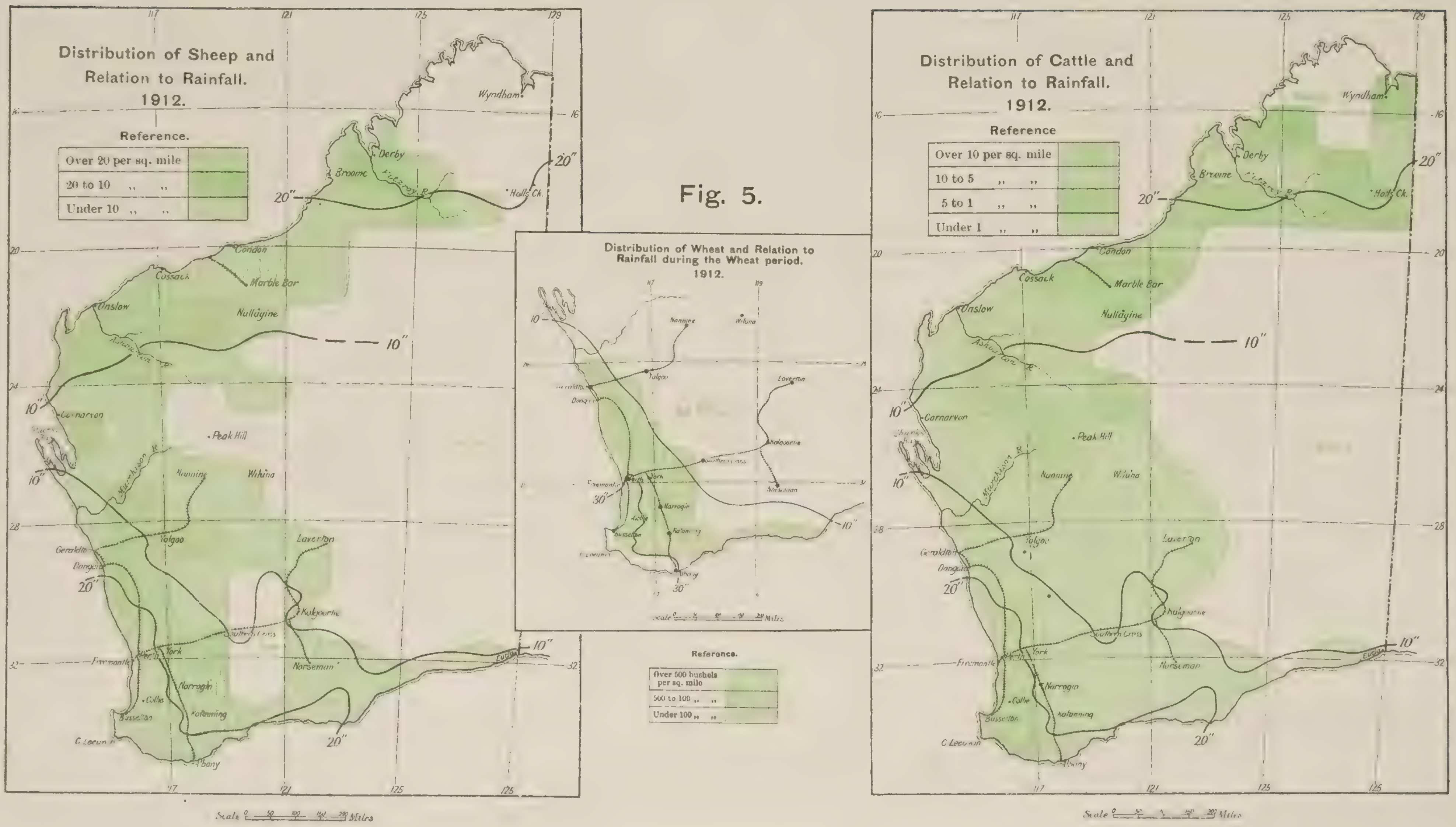
The distribution of sheep in Western Australia is not unlike that of the cattle, but two differences are apparent. The sheep do not extend so far north, nor so far inland. The farm belt in the south-west (in what I have called "Swanland") exhibits the greatest density. Around Perth there are 50 sheep to the square mile, and near Carnarvon and Port Hedland there are considerable areas with over 20 sheep to the square mile.

WESTERN AUSTRALIA.

Fig. 3.

Fig. 5.

Fig. 4.



Distribution of Sheep and Relation to Rainfall. 1912.

Reference.

Over 20 per sq. mile	🟩
20 to 10 ,, ,,	🟩
Under 10 ,, ,,	🟩

Distribution of Wheat and Relation to Rainfall during the Wheat period. 1912.

Reference.

Over 500 bushels per sq. mile	🟩
500 to 100 ,, ,,	🟩
Under 100 ,, ,,	🟩

Distribution of Cattle and Relation to Rainfall. 1912.

Reference

Over 10 per sq. mile	🟩
10 to 5 ,, ,,	🟩
5 to 1 ,, ,,	🟩
Under 1 ,, ,,	🟩

Owing to the greater difficulty of droving, the sheep areas do not lie so far from the coast or from railways as do the cattle regions. The number of sheep within the arid region is unimportant, except near Carnarvon. The northern limit is at Derby, but since a fair number are reared on the Fitzroy River it seems probable that they will do equally well in the adjacent Ord River region where climatic conditions are similar.

From a survey of the present distribution, the most promising regions for further increase would appear to be along the south coast from the Perth–Albany railway eastward. Here large areas with more than 10 inches of rainfall are practically unoccupied.

8. Wheat in Western Australia. (See Fig. 5.)

During the season 1912–13, over 9,000,000 bushels of wheat were grown. This places Western Australia fourth in the list of States. Since 1905 the States have not increased their wheat yield notably, except in Western Australia, which has quadrupled its supply. The yield per acre for ten seasons was 10½ bushels, being slightly below that of the other States, except South Australia.

A reference to the map shows that all the wheat was grown in the south-west region (" Swanland "), and it is obviously controlled by the 10-inch winter isohyet (for the period April–October). There seems little doubt that almost the whole of this corner will ultimately grow wheat. Probably, however, the portion along the coast averaging over 30 inches will be wholly given over to dairying eventually.

The best yields come from the region around York (over 500 bushels to the square mile), and thence the optimum wheat zone is extending north and south between the isohyets of 15 and 20 inches of winter rain. The greatest progress is being made towards the south-east, where some half-dozen new branch railways are opening up the wheat belt.

FUTURE PROSPECTS.

The map indicates that large areas of suitable country between Narrogin and the Bight remain untouched. Mr. Hunt has reported that 93,500 square miles with suitable rainfall are available in this State. This is considerably more than in Victoria, which has less than 80,000 square miles of similar land.* If the wheat yield grows to the same proportions as in the latter State, and at its recent rate, we may look forward to an annual yield of 30,000,000 bushels of wheat from Western Australia in the next ten or fifteen years.

III.—NORTHERN TERRITORY.

9. Climate of Northern Territory.

The greater part of this region lies in the tropics, and the temperature ranges from 82° at Darwin to 70° at Charlotte Waters in the south. The annual temperature range at Darwin is very small, from 84.2 in March, to 77.2 in July. The chief seasonal variation is shown in the rainfall. In January an average of 15 inches falls, while throughout the whole of winter (June–September) there is less than an inch of rain.

In the far south at Charlotte Waters (26° S.) the rainfall is very low, being only 5½ inches a year ; but from its continental position the temperature range is large. In January the average is 83°, while in July it is 52°—a range of nearly 30° as contrasted with 7° at Darwin.

The isohyets run across Northern Territory and form the basis of a useful subdivision. The northern portion, with a rainfall over 35 or 40 inches, is low-lying and still not well known away from the Pine Creek railway. The soil is reported poor in plant food, and the country as a whole does not appear to be well-suited for cattle. Between Katherine (40 inches) and Powell's Creek (20 inches) extends the most promising portion of the Territory, for the climate is more healthy, and this area is well adapted for cattle. The dry region occupying almost the southern half of the Territory is almost unoccupied, except for a few stations in the Macdonnell Ranges.

---

* Probably one-quarter of this (mostly over 2,000 feet) is much too rugged for any agriculture.

The topography exercises little influence on settlement in the Territory. The whole country forms part of the Western Plateau, and lies about 1,000 or 1,500 feet above sea level. Only in the far south are any notable elevations in the shape of the Macdonnell Ranges. These rise to 4,818 feet.

10. Cattle in Northern Territory. (See Fig. 8.)

In 1912, there were 405,552 cattle in the Territory. Their numbers have not increased rapidly—probably owing to difficulties of communication—and, indeed, were much the same in 1908. The increase from half the number (in 1890) has taken over twenty years, so that the cattle industry is not going ahead as in Western Australia. Northern Territory is fifth in order of importance.

I owe to the Department of External Affairs the data which are embodied on the map. The returns were made out for six divisions grouped around Victoria River, Roper River, Barkly* Tableland (around Brunette Downs), Alice Springs, McArthur River, and "outside districts." As the area in square miles was given for each district, I drew circles around the respective centres of approximately the given areas. This enables the reader to gain some idea of the distribution of the cattle in the Northern Territory.

Region.	Cattle.	Area in Square Miles.	Density per Square Mile.	Sheep.
Victoria River	280,516	50,633	5·6	..
Barkly Tableland	147,956	33,302	4·5	58,000
McArthur River	20,400	7,914	2·5	..
Roper River	13,200	6,714	2·0	..
Alice Springs	26,306	33,075	0·8	9,070

The unspecified regions carried 16,500 cattle on 19,300 square miles. Obviously this latter area is unimportant compared with the vast extent of the Territory absolutely unoccupied. The number of head stations is given in the table in Section 11.

FUTURE PROSPECTS.

Turning to older settled regions as a basis of comparison, we see that in Queensland in an area of 290,000 square miles between the 20 and 40-inch isohyets there are over ten cattle in each square mile. In Northern Territory there are 133,000 square miles† which have a climate sufficiently similar for a rough approximation. Hence the Territory should be able to support three times its present stock without arriving at any greater density than the moderate figure which still obtains in Queensland.

The slow rate of increase in the Territory will be quickened when the new Queensland railway is completed to Camooweal and, perhaps later, linked to Pine Creek. Until communications are improved, there is no possibility of the Territory arriving at its proper cattle production; but it may be noted that the Queensland figures rose from the same figures (400,000) to over 1,000,000 in a period of ten years during the phase of greatest expansion (1860–1870).

11. Sheep in Northern Territory. (See Fig. 8.)

There were in 1912 only two areas where sheep were stocked in the Territory, *i.e.*, on the Barkly Tableland and around Alice Springs. There were 58,000 sheep at the former locality, with a density of about 2 per square mile; and 9,000 sheep in the southern highland country.

This hardly gives us data enough on which to base any forecast. The rainfall is 20 inches in the northern area and 10 inches in the southern area. In Queensland the sheep are distributed over the area between the 10-inch and 30-inch isohyets, and there are nearly 300,000 square miles between these lines in the Territory. At the same time reports as to the nature of the country south of 20° (Tennants' Creek) seem to show that in spite of its rainfall (10–15 inches) it cannot be considered very satisfactory stock country. Only in the Macdonnell Ranges and near the streams flowing from those highlands is there sufficient pasture and permanent water.

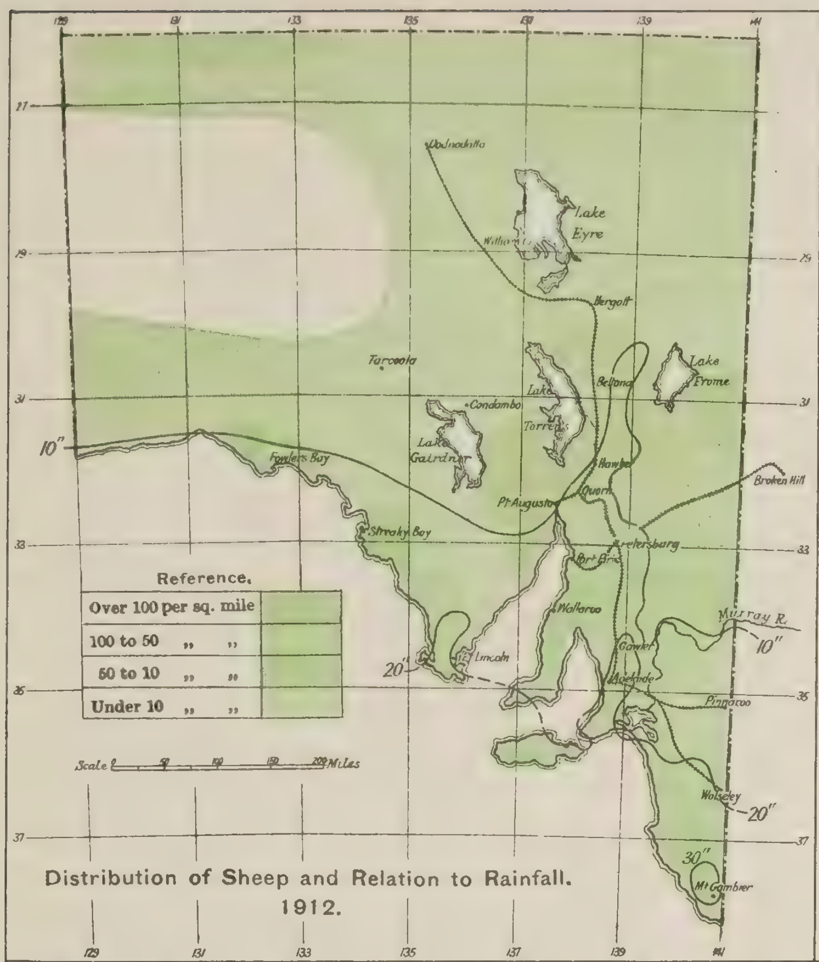
---

* Named after Governor Barkly by Landsborough, and often spelled wrongly. (*Fide* Mr. Atlee Hunt).

† These areas are given by Mr. H. A. Hunt in the official *Year Book*.

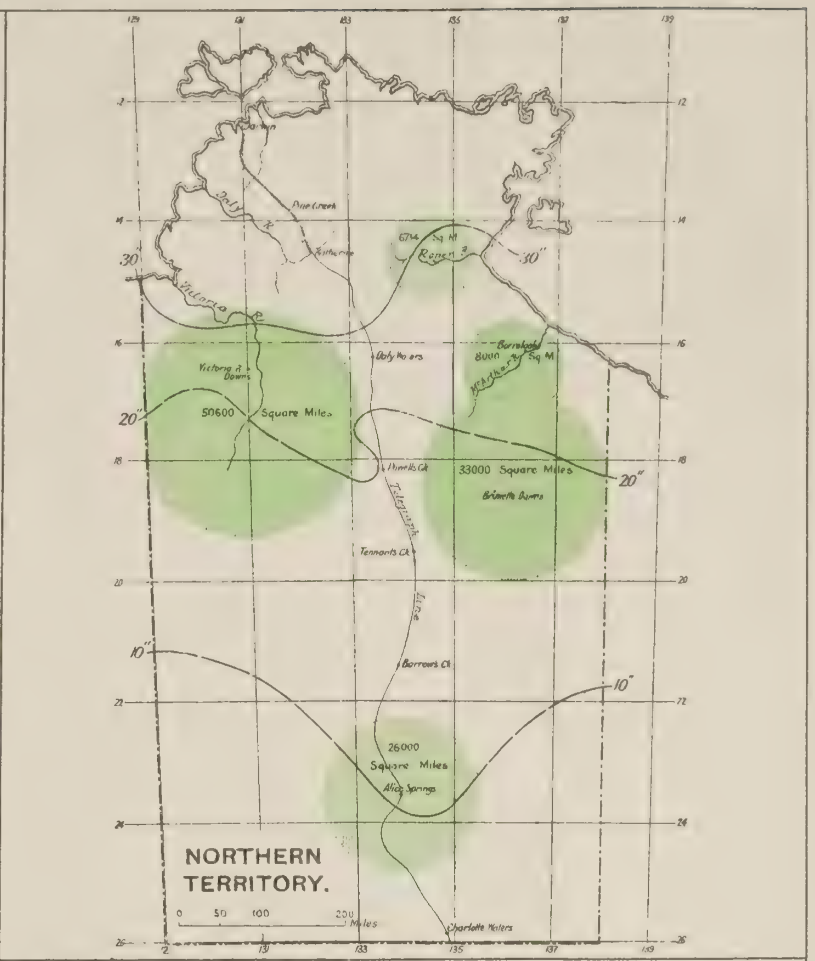
SOUTH AUSTRALIA.

Fig. 6.

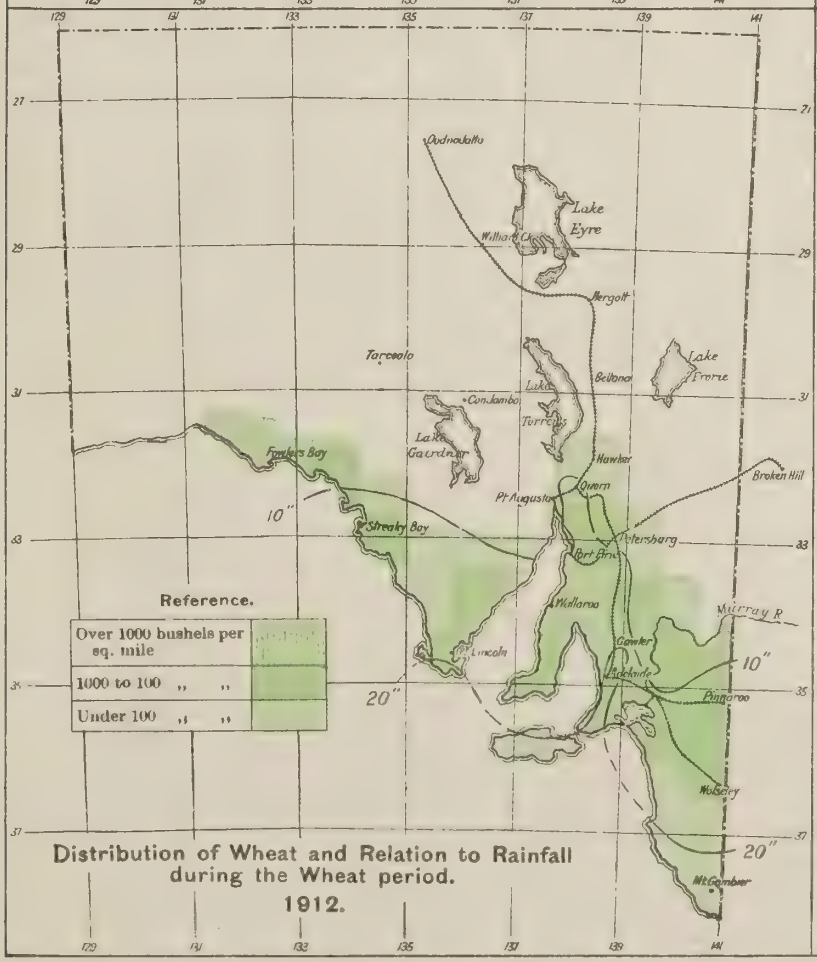


Distribution of Sheep and Relation to Rainfall.
1912.

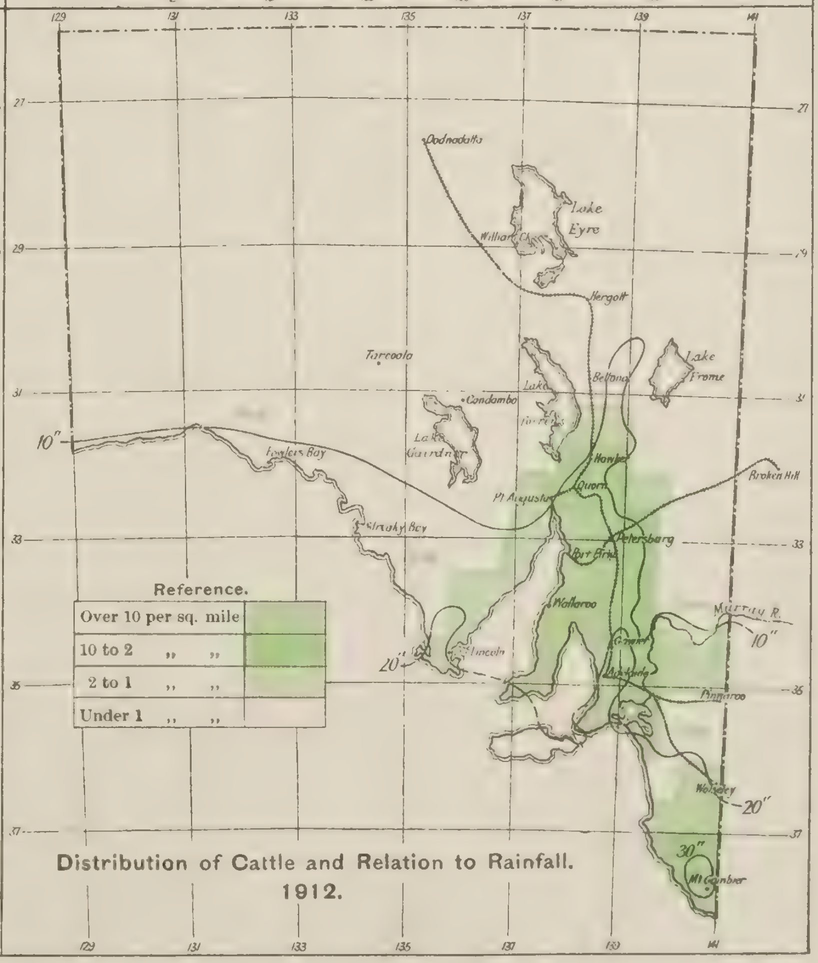
Fig. 8.



NORTHERN TERRITORY.



Distribution of Wheat and Relation to Rainfall during the Wheat period.
1912.



Distribution of Cattle and Relation to Rainfall.
1912.

Fig. 7.

Scale 50 100 150 200 Miles

Fig. 9.

Mr. H. Y. L. Brown (late Government Geologist), has given a very useful map of the Territory, with the areas classified as to their pastoral possibilities (1909). The chief results are included in the following table :—

Type.	Character.	Locality.	Area in Square Miles.	Pastoral Data, &c.
A	Excellent (9 head stations)	Barkly Tableland, &c., Powell's Creek to Camooweal	29,000	Possibly agricultural
B	First class (6 stations)	Victoria Basin to Katherine ..	34,000	Well grassed and well watered
C	Second class (4 stations)	Coastal belt, about 150 miles wide ..	158,000	Good soil on rivers ; good feed after burning
D	Third class (17 stations)	Central strip, 100 miles wide. Daly Waters to Charlotte Waters	148,000	Patches of pastoral country along creeks. Twelve of the stations are in the Macdonell Ranges or on creeks flowing south from them
E	Fourth class (no station)	Strips west and east of " D " ..	162,000	Spinifex and sandhill country

Probably under present conditions of difficult communication sheep will not spread much, and it is to cattle that the Territory will owe its future prosperity.

IV.—SOUTH AUSTRALIA.

12. Climate.

This State lies wholly in the Temperate Zone, the average annual mean temperature ranging from 70° F. at Charlotte Waters to 58° in the extreme south. The northern inland region has a temperature range of 30°—from 85° in January to 55° in July ; while Mount Gambier is much more equable, varying from 65° to 50° in the same period.

The greater part of the State is included in the winter rain region. The country to the north of William Creek (29° S.) receives most of its rain in summer, but as it only averages 5 or 6 inches a year, this area is of little economic importance. The State is popularly divided into (*a*) the "counties," and (*b*) the undivided northern region ; and this partition is practically based on the 10-inch rainfall line. There are two regions with a rainfall over 25 inches per year. The northern, extending from Angaston to Cape Jervis, gains it from its elevation ; the southern, in the extreme south-east, from its latitude.

The topographic factor is of considerable importance in controlling the rainfall—and, therefore, the productions of the State—in the east; but this is not the case in the west. In the west, the Great Australian Plateau rises gradually from Lake Gairdner (366 feet) to the Musgrave Ranges, which are said to reach over 5,000 feet. Yet there is no appreciable effect on the rainfall, the whole being under 10 inches and, apparently, becoming drier as the land increases in elevation.

The reason for this aridity in the north-west of South Australia may be briefly mentioned here. We have no rainfall observers in the region, but the monthly pressure maps of the Continent show that during a great part of the year the average conditions are (*a*) an area of *low* pressure over the north-west coast, and (*b*) an area of high pressure over the Bight. The winds south of a Low and north of a High both have a strong eastward component, so that in the region between a more or less permanent Low and more or less permanent High, there must be a large preponderance of east winds. These east winds have already traversed large land areas, and are in general blowing from cooler to warmer areas. They are, therefore, tending to absorb moisture rather than to precipitate it, and, as a result, we get the arid region of Australia.

The presence of the Flinders Range is responsible for the bulge to the north of the South Australian isohyets. From Adelaide up to Lake Callabonna (30° S.) there is an almost continuous series of mountain ranges, most of which reach nearly 3,000 feet*. Were it not for these mountains the rainfall at Clare would be only 10 inches instead of 24, and of Blinman 6 inches instead of 13, so that they have added to the "over 10-inch" country a strip nearly 250 miles long. The rain bearing Antarctic "Lows" affect all this region; but, unfortunately, do not extend as far north as the Musgrave Ranges (26° S.), so that the high elevation of the latter does not lead to the cooling of *moist* winds, as in the case of the Flinders Range.

---

* A recent official map gives Mount Lofty (Adelaide) 2,334 feet ; Razorback (Kooringa), 2,835 ; Mount Brown (Quorn), 3,200 ; St. Mary's Peak (lat. 31° 30′) 3,900 ; and Benbonyathe (lat. 30° 30′), 3,470.

13. Cattle in South Australia. (See Fig. 9.)

In 1912 there were 383,418 cattle in the State. South Australia is one of the smallest producers of cattle, being superior only to Tasmania in this respect. There are three centres of cattle raising. The county of Adelaide has about 27 cattle to the square mile—the density being largely due to dairies. The same applies to the Mount Gambier region, where the cattle increase in density from Bordertown southwards to fourteen per square mile. Around Port Pirie the cattle are numerous also, averaging ten to fourteen per square mile. Elsewhere the raising of cattle is unimportant and, as the map shows, very few are raised beyond the 10-inch isohyet. Owing to the limited extent of South Australia with a rainfall over this amount (62,000 square miles out of a total of 380,000), all of which is now fairly accessible by rail or steamer, it seems unlikely that any great increase in the number of cattle is to be looked for. Moreover, the figures have not altered materially since 1890 (except for the decrease during the 1902 drought). Probably the unoccupied regions with a fair rainfall—around Coonalpyn and in Eyre's Peninsula—will be devoted to wheat and sheep rather than to cattle.

14. Sheep in South Australia. (See Fig. 6.)

In 1912 there were 5,481,489 sheep in this State, which ranked fourth among the States, containing only 6½ per cent. of the total sheep of the Commonwealth. The number was larger in 1875, and has been slowly decreasing, so that little increase is to be expected under present conditions.

Sheep are spread over the State to a much greater degree than cattle. Even in the far north-west in the Musgrave Ranges there are a few flocks, though the region to the south of these highlands is unoccupied until the coast is approached.

The sheep are densest in the Mount Gambier region, where the two southern counties have about 200 sheep to the square mile. The other chief grazing area—around Adelaide—varies from 100 to 160 per square mile.

The distribution is not so closely controlled by the rainfall as might be expected. Two empty areas with suitable rainfall—around Pinnaroo and in Eyre's Peninsula—are probably to be accounted for as being largely occupied with wheat growing. Along the Broken Hill railway are large areas where the sheep are much more numerous than in other regions beyond the 10-inch isohyet. This would seem to imply that similar country in the Lake Gairdner region and westward will, assuredly, be much more heavily stocked when the new railway is complete.

The area "beyond the counties" is only approximately mapped. The statistical reports do not give the areas occupied by the sheep, but merely the numbers in somewhat ill-defined districts. However, it is fairly correct to say that the 7-inch isohyet bounds the region containing more than ten sheep to the square mile. As will be seen, however, there are many stations which have a lower rainfall than 7 inches per year, and, probably, 250,000 sheep pasture in these drier areas.

15. Wheat in South Australia. (See Fig. 7.)

This State produces far more wheat than any other per head of population, though the total crop is only third among the six States. In 1912–13 the crop was 21,496,216 bushels, and this amount had not varied much in the last seven years. The yield per acre was, however, the lowest among the States, being 10.30 bushels, while Tasmania produced 20 bushels per acre.

The five counties north of Adelaide are the chief producers, Daly (around Wallaroo) reaching 1,690 bushels per square mile. This well-defined area is absolutely controlled by the isohyets, and its relation to the rainfall from April to October is shown on the map. In this State we may safely assert that a fall of 15 inches during the growing period is the optimum amount.

The Pinnaroo regions and Eyre's Peninsula are also important wheat areas, and as far as climate is concerned, should produce just as much wheat as the Wallaroo region. Their development is bound up with that of the railways, and much larger yields may be expected when these areas are fully occupied.

The extreme boundary of the wheat-growing area appears to be the 6-inch winter isohyet, which runs approximately parallel to the 10-inch line and about 25 miles outside it. This is considerably beyond Goyder's well-known line, which was based on the native flora, and was indeed within the 10-inch wheat rainfall line.

Mr. Hunt gives the area enjoying more than 10 inches during the wheat period as 46,980 square miles. If we assume that only half of this is suitable for wheat*, *i.e.*, 23,000 square miles, and that 10 bushels per acre (or 6,400 bushels per square mile) can be raised, we arrive at the large amount of 147,000,000 bushels.† This is the figure to be aimed at before South Australia can be said to have reached her maximum wheat yield.

V.—QUEENSLAND.

16. Climate in Queensland.

The greater portion of this State lies in the Tropics, but several factors—notably the constant south-east winds and the elevation of the eastern littoral—have made Queensland much more productive than other portions of the Australian tropics. As Queensland extends through 16 degrees of latitude it is natural that the temperature varies considerably. The three following stations on the far north coast, on the south-east coast, and in the far south-east interior respectively will give the key to the variation.

Station.	Average Temperature.	January.	July.	Range.
Thursday Island	*81·0	86·8	78·6	8·2
Brisbane	68·8	77·2	58·0	19·2
Windorah	*72·0	87·3	55·3	32·0

* Approximate.

The whole of Queensland lies in the summer rain region. But the eastern coast as far north as Cooktown also receives a good winter rainfall, largely owing to the persistence of the south-east trades. The wettest spot in Australia is Harvey Creek, close to Cairns, and from here (165 inches) the annual average decreases, at first rapidly, and then gradually, to the south-west, where Birdsville has less than 10 inches per year. Only the extreme south-west can be called arid country, and no other State has such large tracts of land between the 10-inch and 30-inch isohyetals.

The topographic factor is of some importance. The Cairns hinterland, lying just where the constant onshore winds are compelled to surmount a range of 4,000 feet, is peculiarly well situated for heavy rains. The same conjunction of elevated lands and favouring winds obtains all along the east coast, so that around Brisbane and Mackay the rainfall is also over 50 inches. Inland, the precipitation falls off rapidly, the belt of country between the 30-inch isohyet and the sea being rarely more than 40 miles wide.

17. Cattle in Queensland. (See Fig. 11.)

In 1912, the State contained 5,210,891 cattle, being easily first in this respect. The number of cattle has not altered materially since 1890, and for the past few years has been just over 5,000,000. (The information for the map was obtained for 1910, for reasons already stated. The figures for this year were 5,131,699; which is only a difference of 1½ per cent.; and no noteworthy change in the distribution can have arisen during two such similar years).

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* In this State there is practically no region with an excessive rainfall as far as wheat is concerned, so that almost all this 46,980 square miles enjoys ideal wheat rains. This is not altogether the case in the Eastern States.

† Even if half be in fallow, as is usual, the respectable total of 70,000,000 bushels is reached.

Since Queensland is the chief State where cattle are reared for purposes other than dairying, I have thought it well to prepare a special map to show the regions devoted to the latter industry. This shows that the density of cattle around Rockhampton (40 per square mile), and between Bundaberg and Brisbane (40–60 per square mile), is due chiefly to the dairying industry. Apart from these centres, the chief cattle country is along latitude 20°, from Burketown (19) to Townsville (21 per square mile).

RAINFALL CONTROL.

The chief cattle country is seen to lie almost wholly between the 20 and 40-inch isohyets. There are practically no cattle north of Cooktown, though this is probably as much due to inaccessibility and pests as to increased rainfall. Another district with suitable rainfall, but with few cattle, lies along the central railway around Emerald.

Large numbers of cattle are also grazed in the drier region between the 10 and 20-inch isohyets. Around Longreach, however, is a district where cattle are particularly rare. A reference to the sheep map shows that here is one of the densest regions for sheep-raising in Australia and, presumably, the cattle are crowded out. Some few cattle (about two or three to the square mile) are, however, grazed right to the western boundary of the State.

18. Dairying in Queensland. (See Fig. 12.)

The figures given on the map are for the year 1913. Only the dairies in the four districts, Moreton (6,972), Wide Bay (3,808), Port Curtis (677), and The Downs (4,694), were localized in the statistical report, but these constitute 90 per cent. of the whole, so that the distribution as shown is fairly complete.* The dairies are, of course, situated in the districts of constant rainfall, and almost all have more than 25 inches, the greater number being to the east of the 30-inch isohyet.

Obviously other large districts along the eastern coast are suitable for dairying, although at present unoccupied*; while the highland area in the north around Herberton is rapidly becoming important in this connexion, although situated in the low latitude of 17° S.

19. Sheep in Queensland. (See Fig. 10.)

In 1912, there were 20,310,036 sheep in the State. The map shows the distribution for 1910, data for the latter year not being available. However, the number of sheep was almost identical (20,331,838), so that the distribution for 1912 will not differ from that in 1910. The total number has not increased materially since 1890 (18,000,000), but a consideration of the map would appear to indicate that many more sheep can be grazed on the Queensland western country.

The greatest density is around Longreach, where large areas carry more than 200 sheep to the square mile. Toowoomba, St. George, Cunnamulla, Charleville, and Clermont, are other centres with more than 100 sheep to the square mile.

RAINFALL CONTROL.

The sheep region is very well defined by the isohyets—lying almost wholly between the 10-inch and 30-inch rainfall lines. There is very little sheep grazing in the coastal districts, and less in the north and extreme south west. The optimum rainfall for Queensland sheep would seem to be from 15 to 20 inches per year. Most of the region lying between the 10-inch and 30-inch isohyets should carry about 100 sheep to the square mile, for the Cunnamulla district (10–14 inches) shows this density. South of latitude 20° S., there are not many cattle in this belt, and with these boundaries we may allot about 350,000 square miles of good country to the sheep. From a purely climatological point of view, there is, therefore, no reason why the number of sheep should not be doubled.

20. Wheat in Queensland. (See Fig. 13.)

Owing to its northern position there is comparatively little wheat grown in Queensland, the amount in 1912–13 being 1,975,505 bushels. (In New South Wales, 32,000,000 bushels were harvested in the same year.) At the same time there is every reason to suppose that large areas will be grown in the near future, for, as I shall show in a later section, many countries which climatically resemble Queensland, are large producers.

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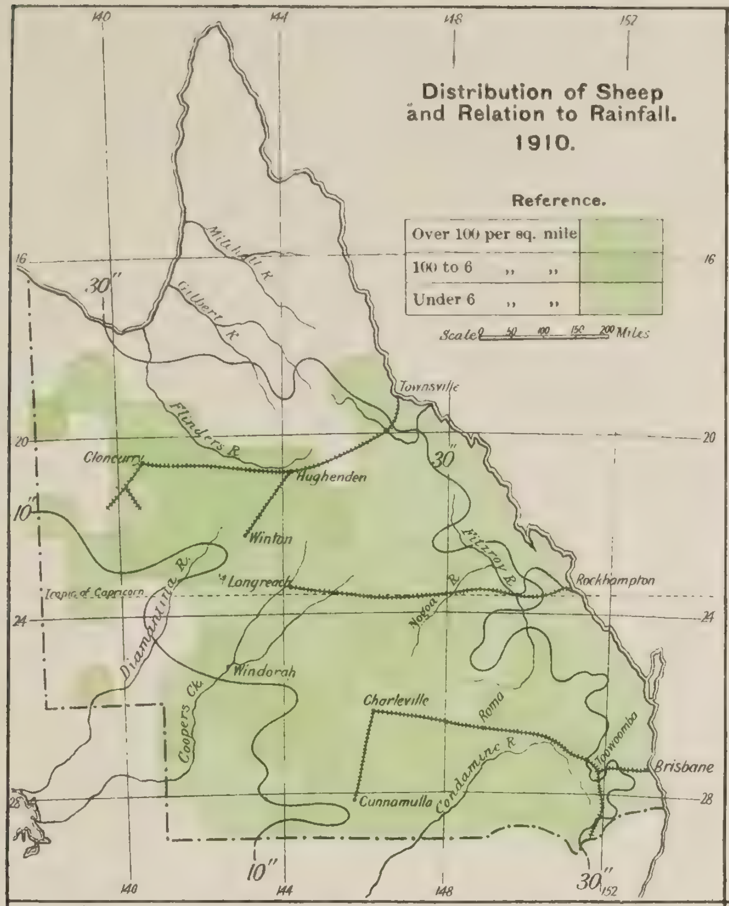
* The Department of Agriculture has since kindly furnished the following additional data :—Mackay District, 100 ; Herberton District, 450 ; Maranoa (Roma, &c.), 700 dairies.

QUEENSLAND.

Fig. 10.

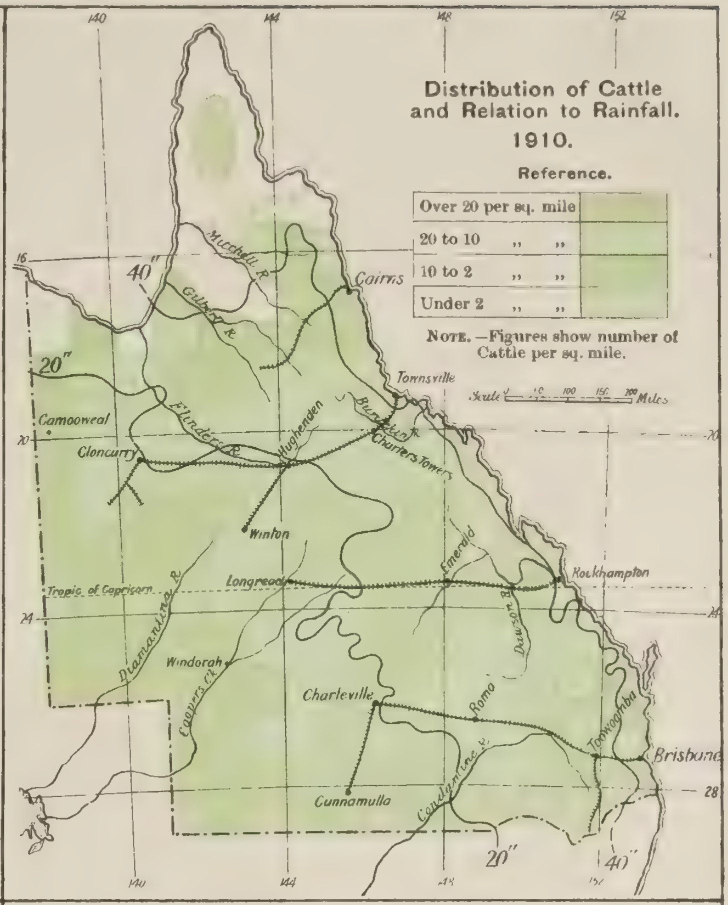


Distribution of Sheep and Relation to Rainfall. 1910.

Reference.

Over 100 per sq. mile	🟩
100 to 6 ,, ,,	🟩
Under 6 ,, ,,	🟩

Fig. 11.

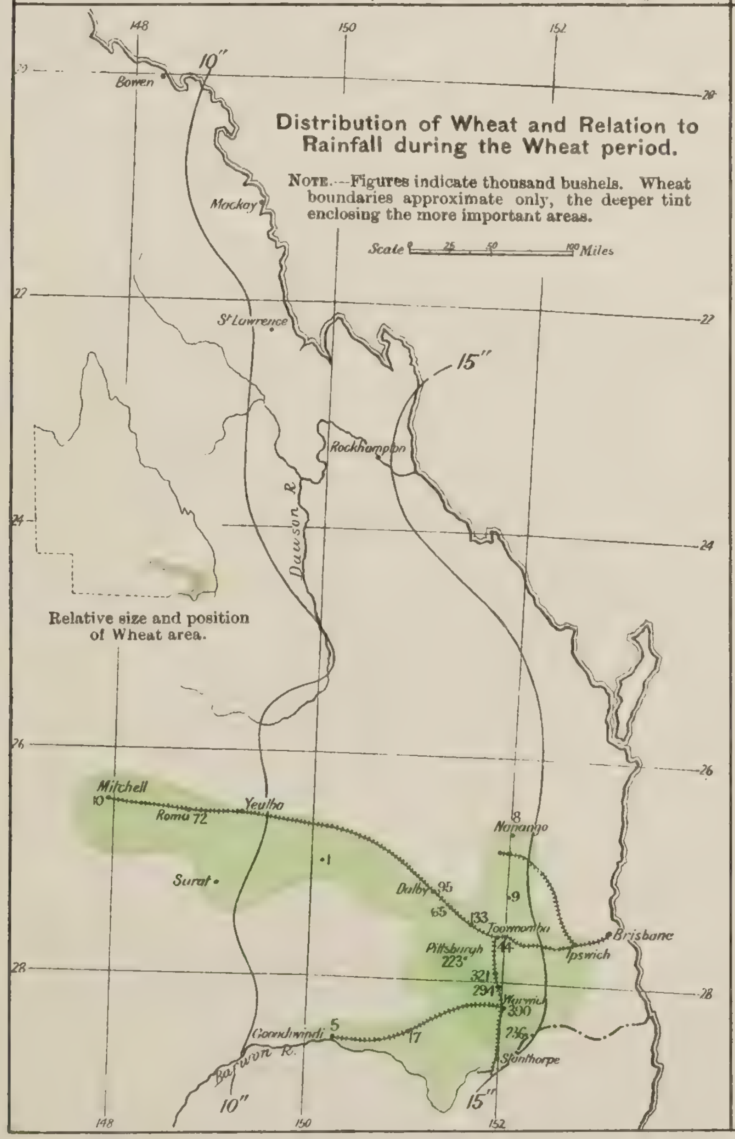


Distribution of Cattle and Relation to Rainfall. 1910.

Reference.

Over 20 per sq. mile	🟩
20 to 10 ,, ,,	🟩
10 to 2 ,, ,,	🟩
Under 2 ,, ,,	🟩

NOTE.—Figures show number of Cattle per sq. mile.

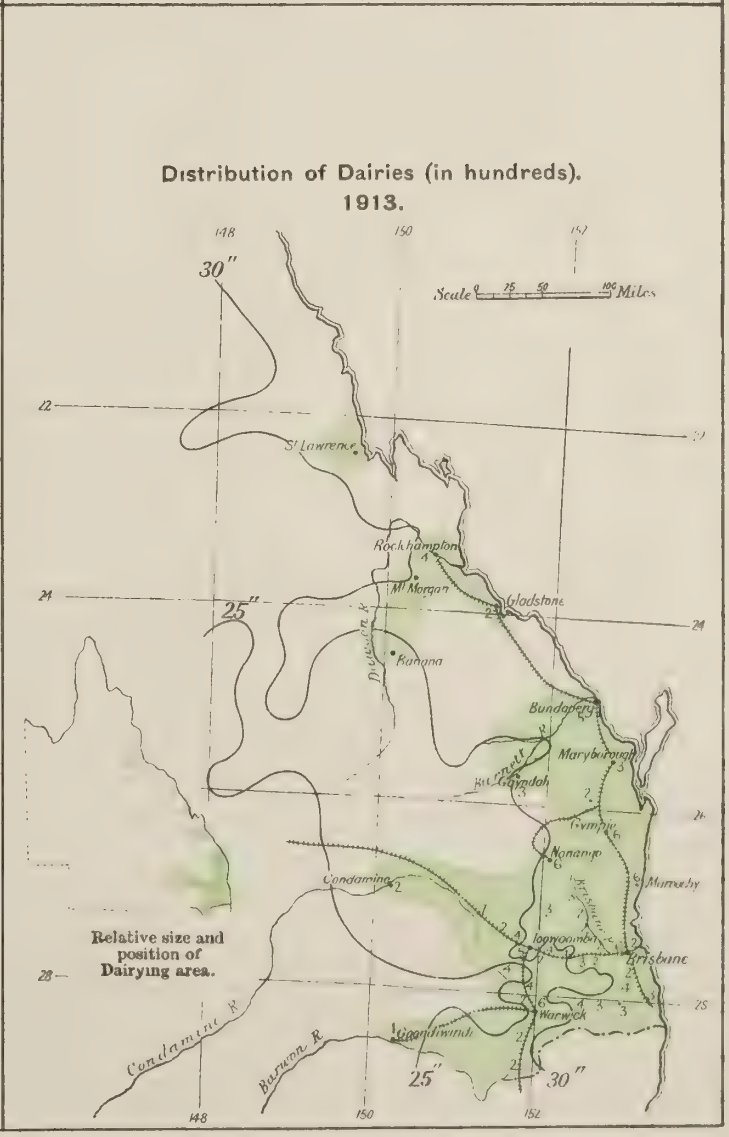


Distribution of Wheat and Relation to Rainfall during the Wheat period.

NOTE.—Figures indicate thousand bushels. Wheat boundaries approximate only, the deeper tint enclosing the more important areas.

Relative size and position of Wheat area.

Fig. 12.



Distribution of Dairies (in hundreds). 1913.

Relative size and position of Dairying area.

Fig. 13.

I was unable to obtain the areas devoted to wheat in Queensland, the data merely recording the number of bushels grown in various centres. These figures, however, have been plotted on the map and show that the northern boundary of the wheat area is about 26° S. Practically the whole of the Queensland wheat is grown on the Darling Downs, but the crops in places like Roma and Surat are of more climatological interest, since they are the present northern limits of wheat-growing.

I have inserted the wheat rainfall lines for 10 and 15 inches, so as to compare conditions in Queensland with those in the other States. The northern boundary coincides with the annual isotherm of 69° F.; but it is obvious that the railway is a more important control of the distribution.

A discussion of the climatic controls governing the crops in U.S.A. and India will be found in a later section. There also, I attempt to show where similar climatic regions occur in Australia, and it will be seen that considerable areas in Southern Queensland are potential wheat granaries.

VI.—NEW SOUTH WALES.

21. Climate of New South Wales.

Almost the whole of the State forms part of the uniform rain region. The portion north of Port Macquarie belongs to the summer rain region, and the south-west corner forms part of the winter rain region belt; the line of uniform monthly rains passes through the middle of the State (from Dubbo to Wilcannia).

The temperature varies considerably between the north-west interior (Tibooburra) and the elevated south-east districts (Kiandra).

——	January.	July.	Annual.	Range.
Tibooburra (in far North-West)*	83·5	52·3	69·1	31·2
Kiandra (4,640 feet)	56·6	29·7	44·0	26·9
Moruya (south-east coast)	69·0	51·8	60·9	17·2

* Five years record only.

The rainfall varies in the same way as the temperature. Tibooburra has about 7 inches per year, while the rainfall gradually increases to the east as the coastline is reached. Along the coast there is an average of 40 inches, but the two wettest regions are around Lismore, in the extreme north-east, where Koreelah has 84 inches, and around Kosciusko, in the south-east, where Kiandra has 64 inches per annum.

The variations in rainfall along the resulting meridional belts are wholly due to the influence of topography. If Fig. 17 be consulted, it will be seen that the highlands may be divided into four main massifs, alternating with broad gaps or "gates." These are tabulated below, and the relation between contour and rainfall will be seen to be very striking :—

Division.	Height.	Rainfall.
New England Plateau	3–5000 feet	35 inches
Cassilis Gate	2000 ,,	25 ,,
Blue Mountain Plateau	3–4000 ,,	35 ,,
Lake George Gate	2000 ,,	22 ,,
Snowy Ranges	3–7000 ,,	50 ,,
Cooma Gate	2600 ,,	20 ,,
Tindery Range	3–5000 ,,	30 ,,

22. Cattle in New South Wales. (See Fig. 15.)

In 1912, there were 3,033,726 cattle in the State, which ranked second to Queensland. There were more cattle in the State in 1875, so that the industry is not likely to advance materially as regards numbers. Dairy cattle will no doubt increase, but in other districts cattle will give place to more intensive industries, so that the net result will probably keep about the same.

The dense cattle regions occur along the north coast, and are due to the spread of dairying in that direction. The following table shows the regions where dairying bulks largely, and it is seen that dairy cattle constitute 38 per cent. of the whole. :—

Division.	Dairy Cows.	Others.	Per cent. Dairy.
Coastal	652,000	902,000	42
Tablelands	88,000	530,000	14
Western Slopes	64,000	362,000	15
Riverina	23,000	99,000	19
Western Plains	16,000	177,000	8
Western	8,000	117,000	7
Approximately	851,000	2,187,000	38

As we progress inland, the proportion of dairy cows to the whole steadily diminishes, as also does the total number of cattle per square mile.

The counties of Rous (around Lismore), Richmond (south of same river), and Durham (north of Hunter River), have the highest figures per square mile. The Illawarra coast is the only region which rivals the north coast, and here also there are more than 40 cattle per square mile.

The northern tableland is a stronghold of the cattle, but in the remainder of the State there are few areas with more than ten cattle per square mile. This is, of course, due to the overwhelming preponderance of sheep, which occupy all the western slopes, plains, and Riverina to the exclusion of all other stock.

The 15-inch annual isohyet approximately bounds the cattle region to the west, while the 25-inch line bounds the major cattle regions on the west. But, undoubtedly, the chief control in the tablelands is topographic, the colder and rougher highland country over 4,000 feet being better suited for cattle than sheep. This explains the cattle regions around Kosciusko, while the less rugged Blue Mountain and northern tablelands also carry considerable numbers of sheep.

23. Sheep in New South Wales. (See Fig. 14.)

This State is universally acknowledged to be the best region in the world for the production of wool. Naturally it possesses more sheep than any other State, and in 1912 there were 38,855,861. This is much less than in previous years; for, in 1909, there were 46,000,000, and as far back as 1891, no less than 62,000,000. There is no doubt, however, that in the latter year the State was overstocked. Unless methods of sheep raising change materially, there is thus not likely to be a very great alteration from 40,000,000 or 50,000,000.

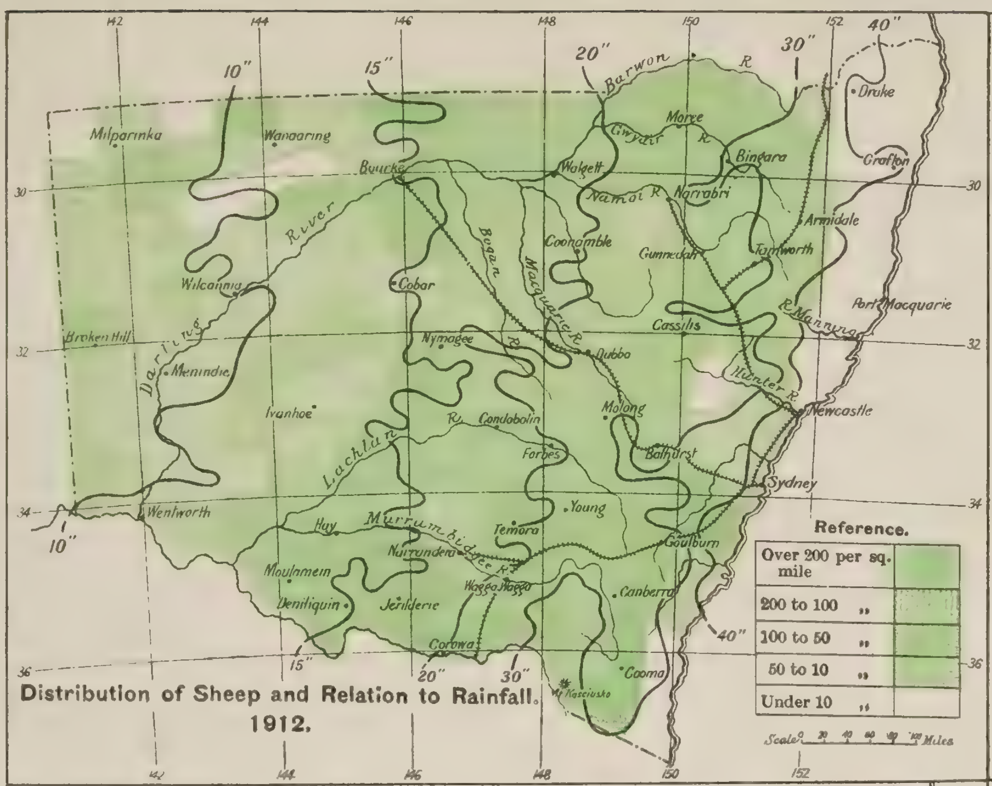
As regards distribution, speaking broadly, there are very few sheep in the wet coastal districts, while the densest regions are the tablelands and western slopes. In the Darling basin the sheep are very much less numerous, though the pastoral industry is still by far the most important asset in that region.

Considering the regions in greater detail, there are about 400 sheep to the square mile in the counties around Armidale (Sandon, Darling, and Hardinge). The belt of country from Goondiwindi (Queensland border) south to Murrurundi (Upper Hunter), has over 300 to the square mile. From Bathurst south-west to Deniliquin the density varies from 200 to 300, with higher figures (about 320) around Yass.

The north coast dairying region carries practically no sheep, and the same is true of the extreme south coast. But Camden and St. Vincent, respectively north and south of the Shoalhaven River, carry about 50 sheep to the square mile.

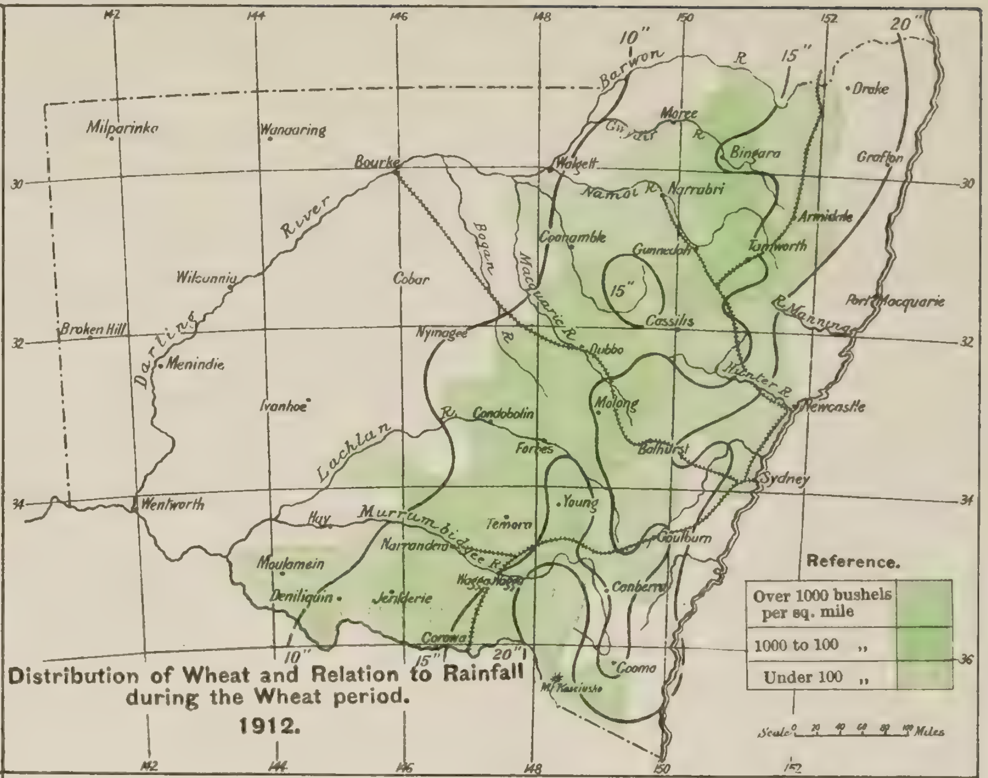
NEW SOUTH WALES.

Fig. 14.

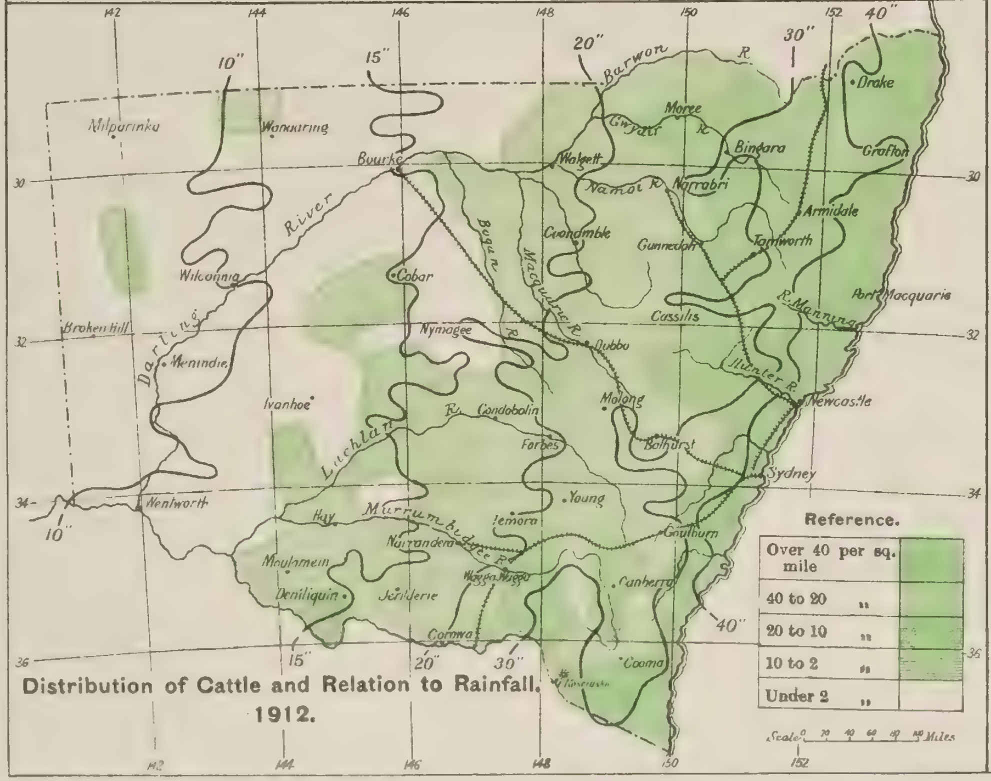


Distribution of Sheep and Relation to Rainfall.
1912.

Fig. 16.

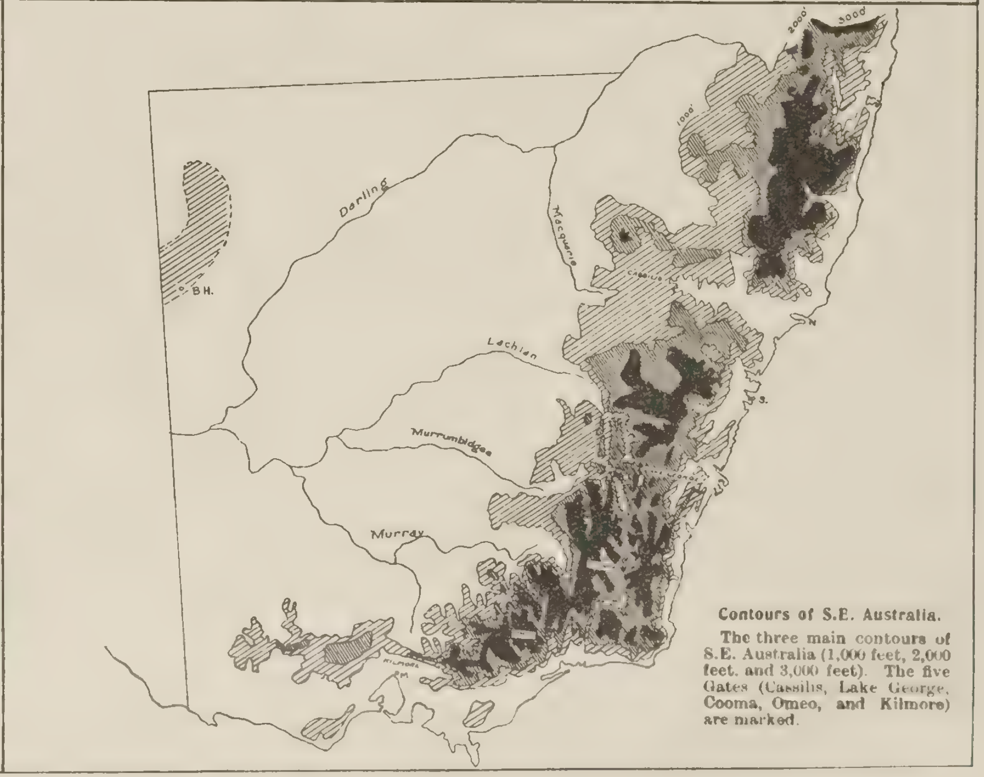


Distribution of Wheat and Relation to Rainfall during the Wheat period.
1912.



Distribution of Cattle and Relation to Rainfall.
1912.

Fig. 15.



Contours of S.E. Australia.

The three main contours of S.E. Australia (1,000 feet, 2,000 feet. and 3,000 feet). The five Gates (Cassilis, Lake George, Cooma, Omeo, and Kilmore) are marked.

Fig. 17.

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The sterile region in the county of Hunter (south of the Goulburn River) and the county of White (south of Narrabri), are localized areas of relatively little importance. Only four other counties, and those in the extreme north-west, have less than ten per square mile. These are Barrona, Fitzgerald, Delalah, and Poole.

RAINFALL CONTROL.

The optimum rainfall would appear to be from 20 to 30 inches in New South Wales. Almost all the densely stocked counties lie between these isohyets, though Sandon county has about 34 inches. The sheep seem to thrive both on the 4,000-ft. plateau of New England and in the low-level plains of the Riverina. From the 20-inch to the 12-inch isohyet there are, approximately, 100 sheep to the square mile. In the drier regions west of the 12-inch isohyet the sheep average about 40 to the square mile.

There are very few sheep raised in areas along the north coast with more than 40 inches, but apart from this, almost the whole State west of the divide is devoted to the sheep industry, the number of sheep decreasing *pari passu* with the rainfall. This might be tabulated as follows :—

Rainfall.	Approximate Number of Sheep per Square Mile.
Chiefly Coastal—	
Over 40 inches	0
30–40 inches	100
Chiefly west of Divide—	
20–30 inches	250
10–20 inches	100
Under 10 inches	40

As regards future developments, these are closely bound up with the increase of transport facilities. These will not only facilitate the handling of sheep and wool in normal times, but will be invaluable in time of drought to transport sheep to areas which are not drought-stricken. In this connexion, a table which I prepared some years ago will be of interest, as showing how rarely a dry period is universal over the State of New South Wales :—

WET AND DRY REGIONS IN NEW SOUTH WALES.

Date.	Above Average.	Below Average.
1903	Trans-Darling, New England, Northern Rivers, Blue Mountains	Western Plains, Riverina
1904	North-west Slopes, Hunter Valley, Illawarra ..	Trans-Darling, Northern Rivers, Southern Tableland, Western Plains
1905	Western Plains, Kosciusko area	North-west Slopes, Trans-Darling, other Highland and Coast
1906	Trans-Darling, Western Plains, Riverina, &c., Kosciusko	Other Highlands and Coast
1907	Northern Plains, North-west Slopes	Trans-Darling, Western Plains, Highlands, and Coast
1908	North Coast and North-east generally	Remainder of State
1909	Highlands and Western Slopes	Far West, Western Plains, Coastal Regions
1910	Far West, West Riverina, North-west Slopes, Blue Mountains	Western Plains, North Coast, Hunter, and Macquarie
1911	Western Plains	North-west Slopes, North Coast
1912	South Coast, South-west Plains	Upper Darling Basin

Of course the same reasoning applies to the other States, even to such comparatively small areas as Victoria. Here also meteorological conditions governing the rainfall of the Mallee differ widely from those bringing rains to the western districts, and both again differ from the rainfall *régime* of Gippsland.

24. Wheat in New South Wales. (See Fig. 16.)

This is the leading State in wheat production, 32,487,336 bushels being grown in 1912. The increase in the yield has been very great, the amount doubling since 1900. The largest yield comes from the south-western slopes along the Murrumbidgee and Murray Valleys. The county of Hume (north of Corowa) produced 1,800 bushels per square mile in 1912–13, and Bourke and Clarendon (both north of Wagga) about 1,400 bushels. The chief wheat belt (over 1,000 bushels) is seen in the map (Fig. 16) to extend from Corowa to Molong. The next grade (1,000–100 bushels) forms a wider belt from the Queensland border to the Murray. It is broken near Cassilis by the rough country of the Warrumbungle mountains. The area producing appreciable amounts of wheat, *i.e.*, counties with more than one bushel per square mile, is a yet broader belt, approximately 200 miles wide, and occupying all the highlands, western slopes, and Riverina.

The total crops per major division are given in the *Statistical Register* as follows :—

Division.	Crop.	Number of Counties.	Average per County.
	bushels.		
Coastal	68,691	18	3,800
Northern Tableland	108,691	9	12,100
Central Tablelands	1,424,329	8	178,000
Southern Tableland	1,671,219	7	238,700
Western Slopes	17,121,551	23	744,000
Riverina	10,917,507	14	778,000
Western Plains	2,702,887	17	160,000
East of Darling	2,576	20	
West of Darling..	2,905	25	

Total .. .. 32,487,336 bushels for the State.

In the above table I have added the average yield per county in the several divisions. The counties are sufficiently of the same size to show clearly enough that the coastal production is negligible, while the whole western division (Darling Basin, with 45 of the largest counties) produced but 5,481 bushels, which is an infinitesimal proportion of the whole.

RAINFALL CONTROL.

If the winter isohyets be plotted as in the map (Fig. 16), then the relation between the wheat isopleths* and the isohyets is extremely close. The 10-inch line is the western boundary of the wheat area except near Walgett, Hillston, and Moulamein. These districts have an average of 9 inches during the wheat-growing period from April to October inclusive.

The optimum is undoubtedly a rainfall of 11 to 15 inches during the growing period, as shown in the maximum belt from Corowa to Molong. A rainfall of over 20 inches in the wheat period apparently fixes the eastern boundary, for only around Sydney is any wheat grown with a rainfall in excess of this figure.

In a later section I discuss the temperature conditions as they affect wheat culture in hot countries.

As regards future prospects, the close agreement of the wheat boundary with the winter isohyet is very significant. The rainfall factor indicates that further extension is to be looked for towards Nymagee (as indeed is taking place since 1912), while all the district from Gunnedah north-west to Mungindi—having the same rainfall as the Dubbo-Condobolin area—should easily grow 300 or 400 bushels per square mile, instead of 10 as in 1912, provided soil conditions are suitable.

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* Isopleth is a general term for such lines as isotherms, &c., describing lines drawn through regions of equal quantities of the object discussed.

OF THE
UNIVERSITY OF ILLINOIS

VICTORIA.

Fig. 18.

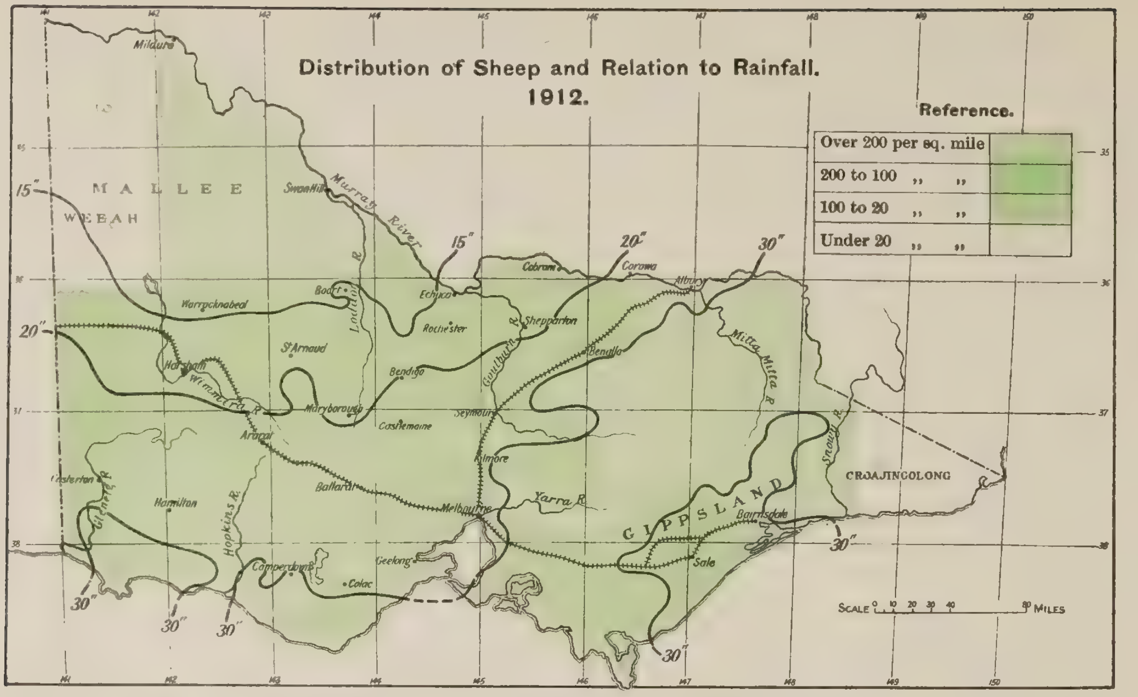


Fig. 19.

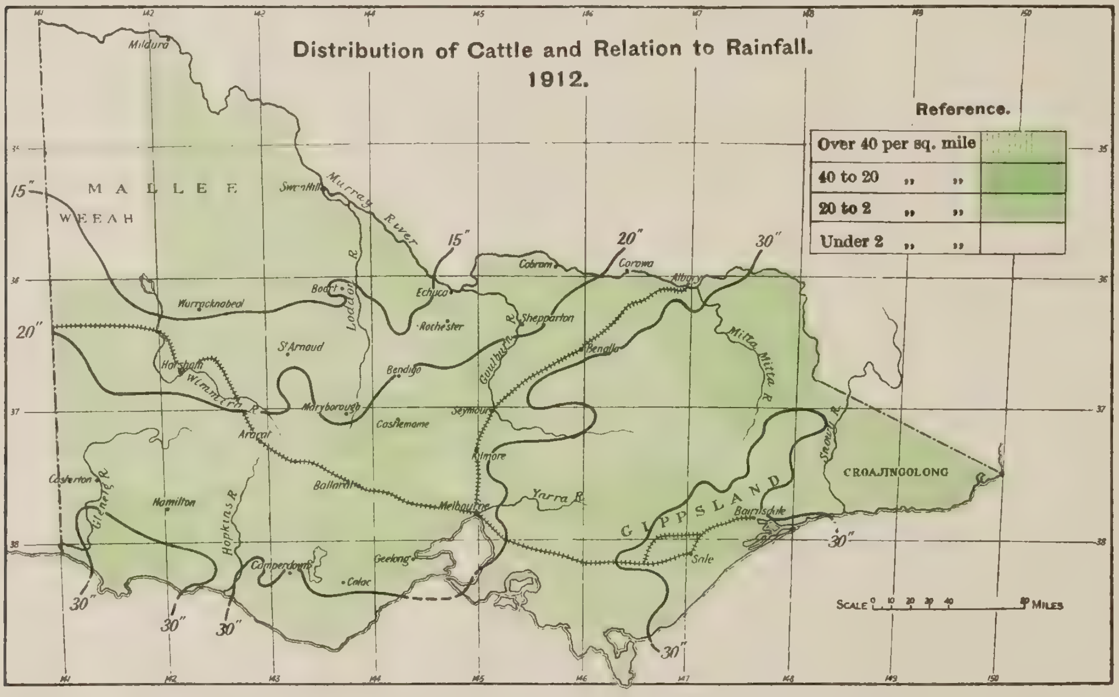
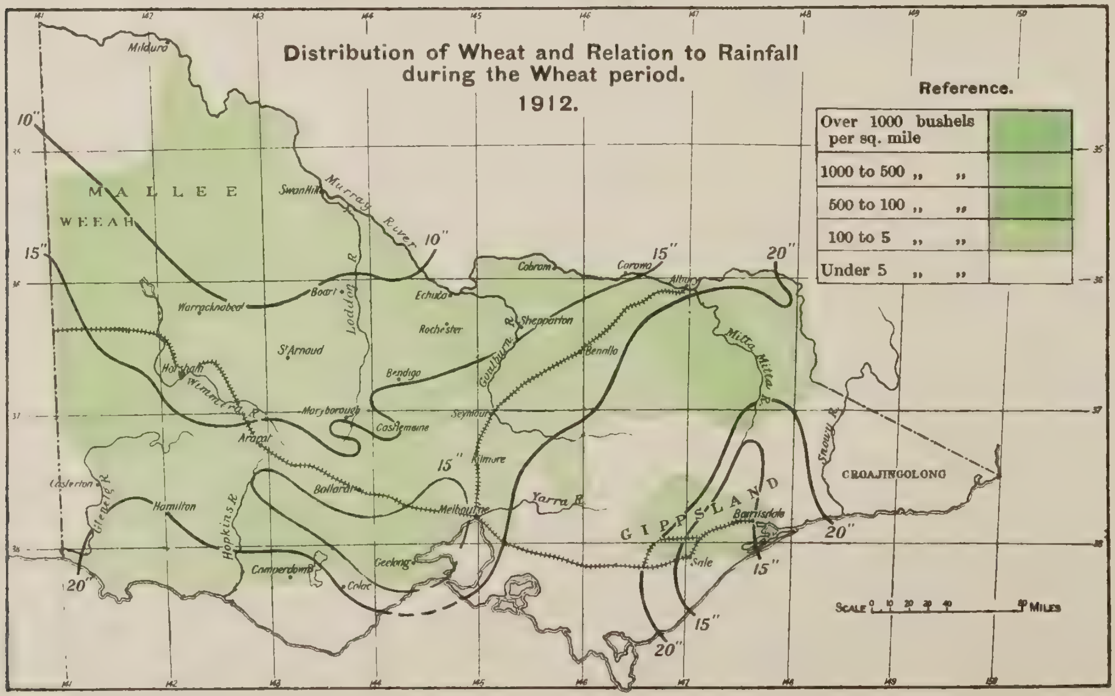


Fig. 20.



VII.—VICTORIA.

25. Climate.

Although this State has a comparatively small area, yet climatically there are four rather distinct regions within its bounds. In the north-west is the dry Mallee country, and in the south-west the fertile western region ; in the east, the rugged mountain area; and in the south-east, shielded by the mountains, is the Gippsland area. The two western areas belong to the winter rain region, and the two eastern to the uniform rain region. The condition of temperature and rainfall are best shown in a table :—

——	Rainfall.	Temperature.			Range.
		January.	July.	Annual.	
Mildura (north of Mallee)	10·8	77·2	49·2	64·0	28·0
Hamilton (in Western district)	26·8	65·7	46·2	55·8	19·5
Omeo (2,104 feet, in mountains) ..	25·4	65·7	40·9	53·6	24·8
Sale (in Gippsland)	24·0	67·7	47·7	58·2	20·0

The same close relation between rainfall and topography is shown as in New South Wales (see Fig. 17). The lowest rainfall is in the north-west near Mildura (10·8), and the heaviest in the south. Beech Forest (near Cape Otway) receives 68·7 inches, but this is an isolated mountain coastal area. Almost the whole of the mountain region in the east receives over 50 inches, culminating in 67 inches at Mount St. Bernard station. The most interesting feature consists, however, in two relatively dry belts. The first belt extends from Ararat to Geelong, and has an average of about 22 inches, and the other dry patch surrounds Sale in Gippsland. These are both due to "rain shadows." They are deprived of their supply by the precipitation of the storm systems on higher lands to the north and west. Probably there is also a foehn effect, due to the warming of the wind by descent on the lee side of the ranges.

26. Cattle in Victoria. (See Fig. 19).

There were 1,508,089 cattle in the State in 1912, which came third in the Commonwealth. Of this number 655,939, or nearly half, were dairy cows, so that the dairying industry accounts largely for the distribution of the cattle. Thus, in the central and north-central districts the dairy cows in all the counties constitute more than 33 per cent. The same holds good for the counties Grenville, Polwarth, Heytesbury, Hampden, Villiers (in the western district), and for Tanjil (Sale) and Buln Buln (south-west of Sale). This constitutes a compact territory south of a line extending from Bairnsdale to Bendigo and to Portland. The three irrigation counties of Gunbower, Rodney, and Moira (around Echuca and Shepparton) also fall into the same category.

Reverting now to the map (Fig. 19) showing the distribution of cattle, the controlling factors can be fairly clearly made out. All the regions with more than 40 per square mile are essentially dairy districts. Buln Buln is highest with 65 cattle per unit area. The far north-west contains practically no cattle, and the alpine county of Wonnangatta is apparently too rugged. These are the regions of least density.

Apart from the Mallee, all the State would seem to be suited to cattle, so that the rainfall control is not very complete. However, it is interesting to note how the dry belt west of Geelong is marked by a decrease in the number of cattle raised. There is no doubt of the suitability of eastern Gippsland for cattle, both dairy and beef, and when the railway is extended, we may expect a considerable increase in cattle density in that district, and also beyond the Snowy River. In the Wimmera district this is not probable, for this country is especially well suited for sheep and wheat. Apart from dairying, there is no reason to expect great increase in the numbers of cattle, which have not altered materially since 1890.

27. Sheep in Victoria. See Fig. 18).

In 1912, there were 11,892,224 sheep in the State. Little change has taken place since 1870, when there were nearly 11,000,000. Victoria ranks third among the States in this respect.

The distribution is fairly general, but the optimum district is well defined. The most important area is a rectangle lying between Bendigo and Portland. The two counties of Villiers and Hampden (north and north-west of Warrnambool) have about 500 sheep to the square mile, while the north-east portion of the above rectangle (see Fig. 18) carries 200 sheep to the square mile. The rather dry country of the Mallee carries few sheep at present, Weeah having only three per square mile, though Tatchera has 85. At the other extremity of the State is Croajingolong, with eleven to the square mile. The alpine counties in the east support about 50 per unit area.

The rainfall control is fairly important. The optimum region—largely consisting of the Western Plains—lies between the 20-inch and 30-inch isohyets. In Victoria a rainfall of 25 inches per year seems to suit sheep the best. The next isopleth (100 sheep per square mile) is approximately determined by the 15-inch isohyet in the north.

The regions over 30 inches carry distinctly fewer sheep than those between 20 and 30 inches. This is due to a combination of several factors. If the country is accessible and fairly level it is better suited for dairy cows and farms; if it is rugged it is better suited for cattle.

28. Wheat in Victoria. (See Fig. 20).

During 1912–13 the State produced 26,223,104 bushels. During the last 10 years the average yield has been about 24,000,000 bushels, and has not varied greatly, so that 1912–13 was a normal year. Victoria is second among the States and not far behind New South Wales (32,000 000).

Four counties had a yield of about 1,000 bushels per square mile. These were Moira (1,100) and Rodney (1,000) in the irrigation region, and Borung (950) and Ripon (920) in the central-west. However, all the counties between Hamilton and Corowa are important wheat producers. The production falls off rapidly to the south and east of this line. None of the counties east of Melbourne are of any importance, except Tanjil (north of Sale). To the north-west are the plains of the Wimmera and Mallee—and these are becoming of increasing importance. Karkarooc and Tatchera would show higher values on the map if they were not such large areas, for their southern portions are very extensively engaged in wheat-growing. A new railway into Weeah will ultimately reach Pinnaroo, and is already opening up large areas of wheat country. Millewa, in the extreme north-west, is not likely to grow much wheat, as its average is only 1 bushel per square mile at present.

RAINFALL CONTROL.

On the map (Fig. 20) the winter isohyets for the period April to October are given. The chief wheat counties are enclosed between the 10-inch and 15-inch winter isohyets.

If the wheat distribution areas be examined, there will be seen to be two outlying districts with yields considerably above those surrounding them. These districts are south of Ballarat and north of Sale respectively. The former area is undoubtedly due to the dry belt extending from Ararat to Geelong, which I have discussed previously. This local dryness shows also in the winter isohyets, as an oval area, enclosed by the 15-inch line on Fig. 20. The three counties of Hampden, Grenville, and Grant are much more important wheat producers than any of their neighbours for this reason.

It is also interesting to note that Gippsland wheat is almost confined to the " rain-shadow " mentioned previously. Around Sale there is a considerable area with less than 20 inches during the wheat period, and this undoubtedly has led to the relative importance of Tanjil among the Gippsland counties. The table following shows that there is comparatively little wheat (on the average, 30 bushels per square mile) grown in areas with over 20 inches of winter rainfall in Victoria. This is, of course, largely due to the mountainous region being included in the wettest belt. The belt from 15 to 10 inches is seen to be by far the most important, while the belts on each side of this optimum grow 200–300 bushels per square mile. Assigning a county to the rainfall belt to which most of its area belongs, we may tabulate the relation of wheat to rainfall, thus :—

Winter Rainfall Belt.	Counties.	Area in Square Miles.	Bushels.	Per Square Mile.
Over 20 inches ..	Benambra, Bogong, Delatite, Anglesey, Wonnangatta, Dargo, Tambo, Croajingolong, Buln Buln, Mornington, Polwarth, Heytesbury, Villiers, Normanby, Evelyn (15)	32,600	918,000	30
20–15 inches	Bourke, Dalhousie, Talbot, Ripon, Hampden, Dundas, Follett (7)	10,900	2,585,000	238
15–10 inches	Tanjil, Grant, Grenville, Moira, Rodney, Bendigo, Gladstone, Kara, Borung, Lowan (10)	26,200	16,917,000	645
Under 10 inches ..	Millewa, Weeah, Karkarooc, Tatchera, Gunbower (5)	17,300	5,815,000	334

There would appear to be great possibilities of increase in the wheat yield in the future. The annual isohyets lie parallel to the winter isohyets on the map, so that their benefits from summer soakage are the same. Hence, as regards rainfall, the large area to the west of the River Wimmera (and between the 10 and 20 winter isohyets) should grow 1,000 bushels to the square mile. This is approximately 10,000 square miles. On the above, by no means optimistic, estimate (for the adjoining county of Borung produces 950), this area should give 10,000,000 bushels in place of the 3,000,000 at present obtained. Of course, many other regions are capable of much greater production than at present, but this west-of-Wimmera region is the one where the rainfall control indicates the greatest possibilities in the near future.

VIII.—TASMANIA.

29. Climate.

Small as is Tasmania, its position and topography lead to considerable variation in climate. The island is almost wholly in the winter rain region. The district around Hobart may, perhaps, be considered an outlier of the uniform rain region, for the south-east corner of Tasmania is climatically related to that of the rest of the State, much as Gippsland is to Victoria.

There is still a large region in the south-west of the State which is totally uninhabited, and for which we have no data. This is largely due to the abundant rainfall, which has led to an alternation of bogs, heath, and forests by no means suited to rapid settlement. There is a large highland area in the centre of the State with an elevation of over 3,000 feet. This is characterized by considerable snowfall in the winter. For instance, in 1914, there were fourteen days with snow at Wihareja, and seventeen days at Tiyena in the previous year. Settlement is, therefore, almost entirely confined to the north and east.

The rainfall reaches 115 inches at Mount Lyell in the north-west, where it is due to the effect of the highland country on the constant south-westerlies. It is lowest near Hamilton in the south-east, where it falls to 19 inches per year. There is thus no region with insufficient rain in the whole State.

The following table shows the main climatic elements at three typical stations :—

——	Annual Rainfall.	Temperature.			Range.
		January.	July.	Year.	
Launceston (in north)	28·1	64·1	44·1	54·8	20·0
Hobart (in south)	23·6	62·4	45·3	54·3	18·1
Zeehan, 579 feet (in north-west).. ..	97·0	57·1	43·8	51·4	13·3

30. Cattle in Tasmania. (See Fig. 22.)

These numbered 222,181 on the 1st March, 1913, and had very slowly increased since 1905 (206,211). The State, owing to its small size, ranks last as a cattle producer. The chief region is along the north coast from Wynyard to Launceston. The valley of the Ringarooma is also an important cattle region. Dairying accounts for 60,000 cattle out of the total, and the chief dairy regions are along the north coast from Wynyard to Scottsdale and around the two chief towns, Hobart and Launceston.

The region with over 60 inches of rainfall per year is seen to be practically unoccupied. The dairy districts of the north have a rainfall varying from 50 in the west to 30 in the east, while around Hobart the rainfall drops to 19 inches. Accessibility to markets seems, therefore, to be the chief controlling factor for the dairies—for as we have seen the rainfall is satisfactory almost everywhere in the north and east. Tasmania is by no means fully developed yet, and cattle, sheep, and wheat follow the railways at present. At the same time the topographic factor here, as everywhere, discriminates between the cattle and sheep country, the cold highlands of the centre and north-east (Ben Lomond region) grazing cattle rather than sheep.

31. Sheep in Tasmania. (See Fig. 21.)

On the 1st March, 1913, there were 1,862,669 sheep in the State, the number being naturally lower than in the five larger States, and constituting only 2·2 per cent. of the whole. It has remained almost stationary for 50 years, and is not, therefore, likely to increase much under existing conditions.

The distribution differs considerably from that of the cattle. The latter depend largely on the dairies, and so congregate along the north coast and around the capital. The sheep districts, on the other hand, lie in th emoderately elevated land between the two chief towns. This region rises from 500 to 2,000 feet (near Oatlands) and is bounded on the west by the basaltic plateau (4,000 feet) containing the lakes. Longford and Oatlands support more than 300 per square mile, and the rest of this belt over 200. The other sheep isopleths are, roughly, concentric with this optimum area. The west is, of course, unoccupied.

The main sheep areas are, therefore, in country with rainfall between 20 and 30 inches; Longford having 24·7 inches per year. With increasing rainfall the number of sheep diminishes until the 60-inch isohyet is reached in the mountainous west. The rainfall control is, therefore, much more evident for sheep than for cattle in Tasmania.

32. Wheat in Tasmania. (See Fig. 23.)

The harvest in 1912–13 was a poor one, reaching only 630,315 bushels, and being one of the lowest for many years. Indeed, the wheat industry is not growing in Tasmania, for much larger crops were obtained in 1860 and thereabouts. In this southern State oats is a much more important crop, totalling 2,257,258 bushels and steadily increasing in value year by year.

The two chief areas surround the two principal towns. In the north, Longford district grows 410 bushels per square mile, and Westbury district 276. Both of these produce considerably more oats. Brighton and the district north of Hobart grow from 100–200 bushels of wheat per square mile. Elsewhere in Tasmania the crop is quite unimportant.

The winter isohyets are plotted on the map and show that all the important wheat country (except perhaps Westbury) receives less than 20 inches during the period April to October. There is no doubt that the temperature is a controlling factor in Tasmania, and that with 49° F. as an average for the winter months (see Fig. 43) the wet climate is on the whole better suited for the hardier cereal oats.

TASMANIA.

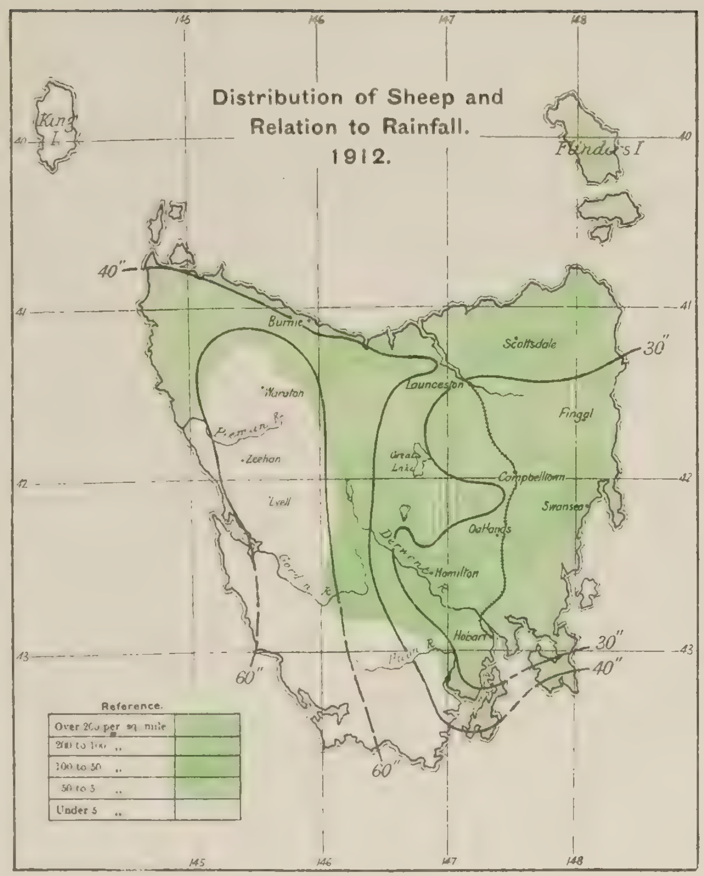
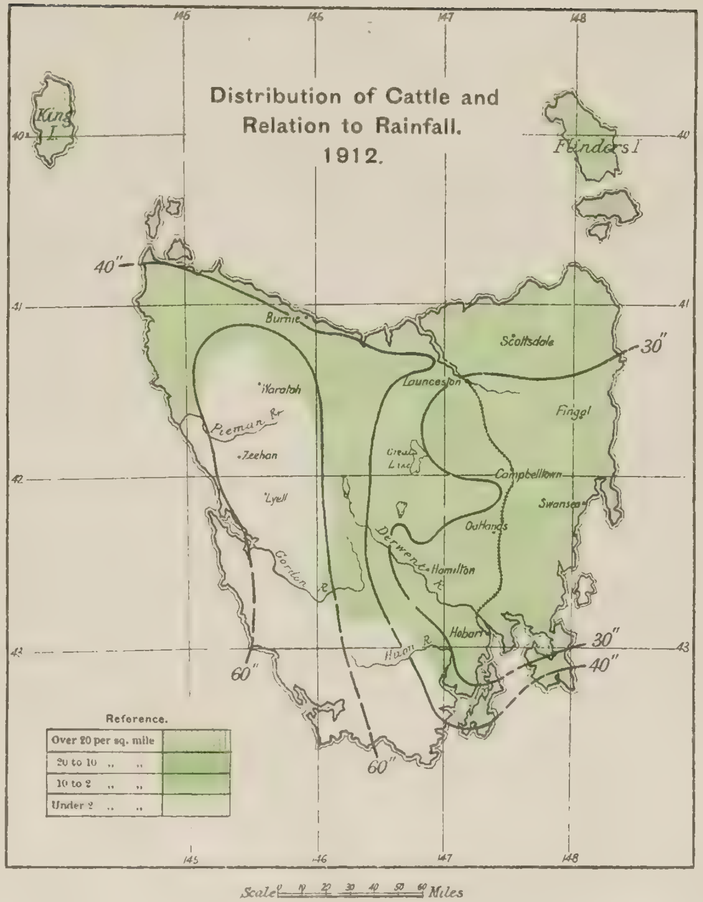


Fig. 21.



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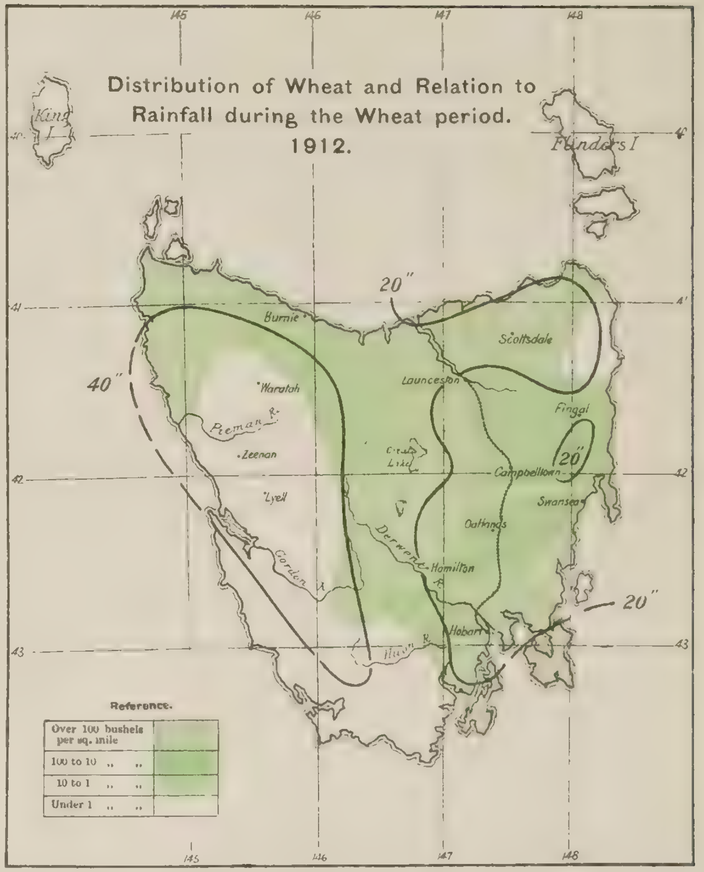

Fig. 23.

IX.—PRODUCTION OF THE CONTINENT AS A WHOLE.

33. Cattle in Australia.

In Fig. 24, the results obtained in the preceding sections and maps are summarized to show the general distribution of cattle throughout the Commonwealth. By far the greater number are reared in the eastern coastal belt. In the three eastern States the cattle occur almost wholly in the wetter region outside the 20-inch isohyet. Assuming that the newer northern and western regions progress along similar lines in the future, then a glance at the rainfall map (Fig. 1) shows that the chief advance will be made in Kimberley (Western Australia) and Northern Territory. The greater part of Western Australia and South Australia has no large areas of unoccupied land with the above favorable rainfall, and must necessarily advance much more slowly than the two regions specified.

Considering now the expansion of the less important cattle areas (shown by dots), it is seen that a few areas outside the 10-inch isohyet are unoccupied by cattle. The large empty space in western New South Wales in Fig. 24 is, of course, already allotted to sheep (see Fig. 25), and the same applies to the patch in central Queensland. In the north-west of Western Australia sheep are occupying the pearling coast, while in the still vacant south-west of this State, analogy would say that sheep would pay better than cattle. Hence we may conclude that only in tropical lands is there much probability of large expansion in the future.

The question of the future distribution of the dairying industry has been dealt with sufficiently in the sections on the individual States. For many years accessibility to markets will confine the dairying chiefly to those districts it has already opened up.

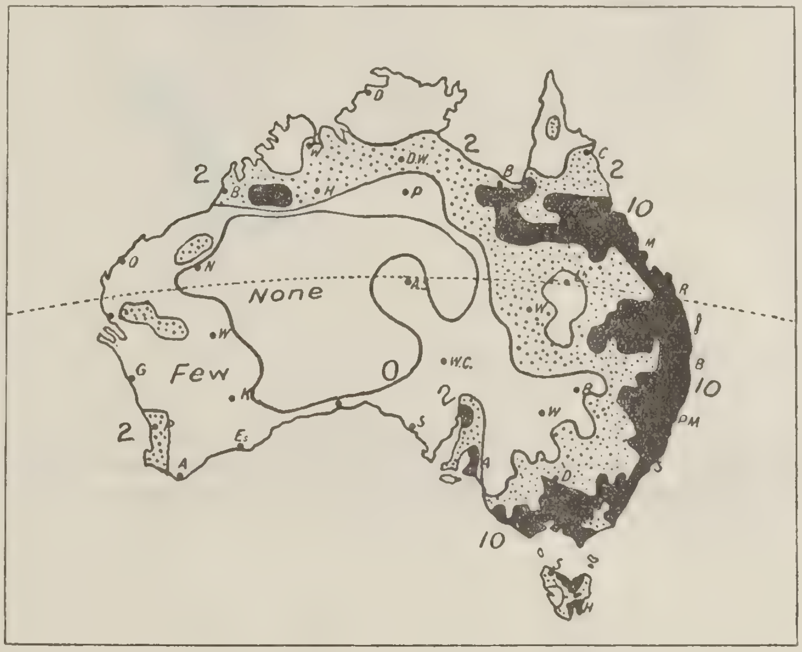

Fig. 24.—Cattle Distribution in 1912. Isopleths 0, 2, 10 per sq. mile.

The following table (mainly based on data given by Messrs. Knibbs and Hunt) shows at a glance the relative importance of the States, and the proportions of cattle reared for dairy purposes. The areas of well-watered country, on which both the future beef and present dairy industries depend, are shown in the middle columns :—

Cattle and Rainfall in Australia.

—	Cattle.	Per cent. of Australia.	Area over 20 inches in Square Miles.		Dairy Cattle.	Per cent. in State.
			Tropical.	Temperate.		
Queensland	5,210,891	45·0	313,183	80,000	375,660	7·2
New South Wales	*3,033,726	26·2	..	130,468	852,040	28·0
Victoria	1,508,089	13·0	..	55,346	655,939	44·0
Western Australia	806,294	7·0	102,606	36,924	27,310	3·0
Northern Territory	405,552	3·5	180,940	..	300	·07
South Australia	383,418	3·3	..	14,875	114,734	33·6
Tasmania	222,181	2·0	..	25,278	60,160	27·0
Total	11,577,259	100·0	..	..	2,086,885	..

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* Plus 7,108 in Federal Capital Territory.

34. Sheep in Australia.

In Fig. 25, the distribution of sheep throughout the Commonwealth is charted from the more detailed State maps given previously. The black areas represent more important regions, just as in the preceding cattle map (Fig. 24). It is interesting to compare the characters of these two maps. The sheep occupy the warm inland drier belt and the cattle the wetter coastal regions. In general, an important sheep country is not noted for cattle, and *vice versâ*—but in New England (New South Wales) and the west-central portion of Victoria, the two industries are intermingled.

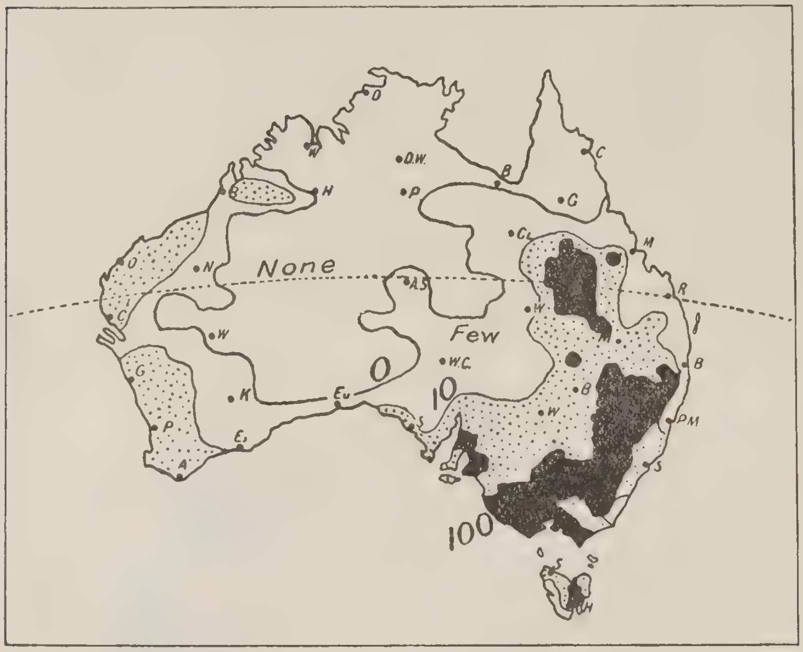


Fig. 25.—Sheep Distribution in 1912. Isopleths 0, 10, 100 per sq. mile.

The best rainfall for sheep in the Queensland tropics is seen to be from 15 to 20 inches. There is a considerable area in Western Australia along the Pearling Coast with this rainfall, and it is indeed already sparsely occupied by sheep (see Fig. 3). The region in the south-west of Western Australia ("Swanland") is analogous in climate and situation to the important sheep country of New South Wales. Hence the chief developments of the future should logically lie in Western Australia, with the result that the present sparsely grazed areas are converted in the near future into closely stocked regions. An extension of the sparsely stocked region (ten-sheep isopleth) to the 10-inch isohyet near Kalgoorlie is also to be expected.

—	Number of Sheep.	Per cent. of Australia.	Rain Control.	
			Optimum Belt.	Total Belt.
			Inches.	Inches.
1. New South Wales	38,855,861	46·7	20 to 30	10 to 40
2. Queensland	20,310,036	24·4	15 ,, 20	10 ,, 30
3. Victoria	11,892,224	14·3	20 ,, 30	10 .. 50
4. South Australia	5,481,489	6·6	20 ,, 30	5 ,, 30
5. Western Australia	4,596,958	5·5	20 ,, 30	8 ,, 40
6. Tasmania	1,862,669	2·2	20 ,, 30	20 ,, 60
7. Northern Territory	75,808	·1	..	10 ,, 20
8. Federal Territory	188,641	.2		
Total	83,263,686	100·0		

THE CLIMATIC CONTROL OF THE WORLD'S WHEAT HARVEST.

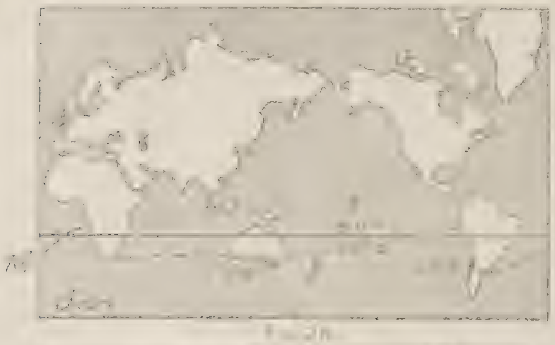
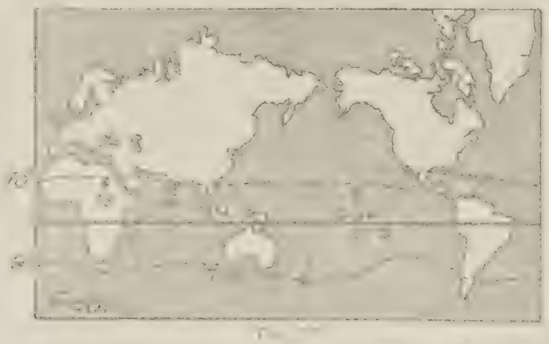


Fig. 26.



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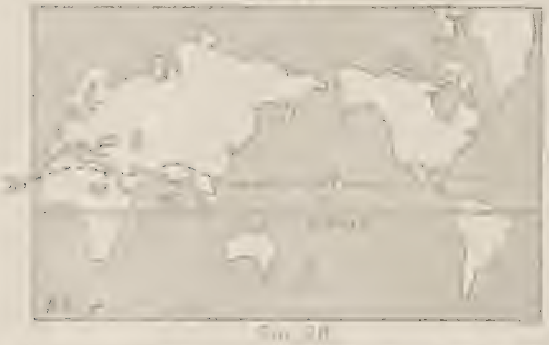

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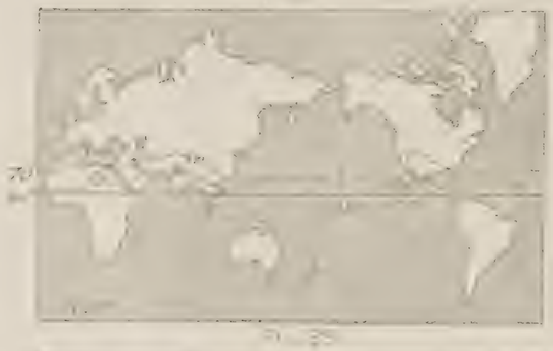

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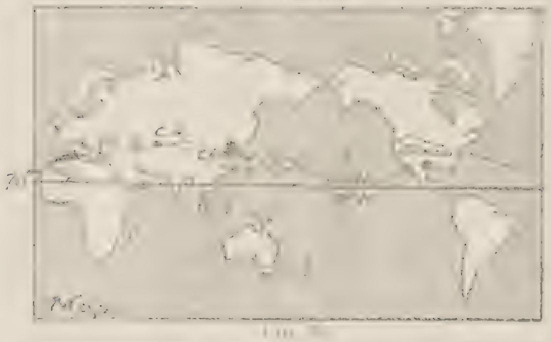

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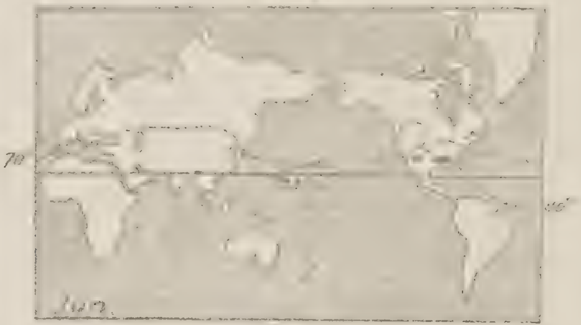

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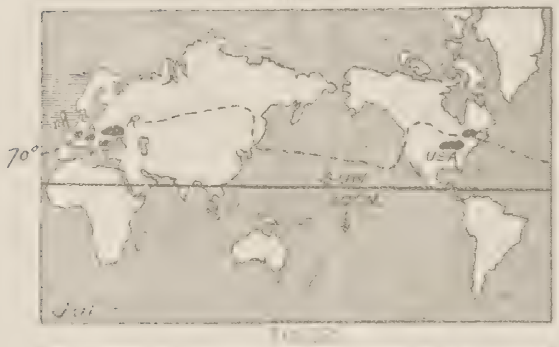

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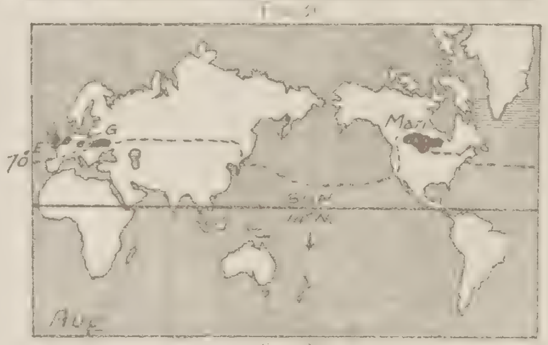

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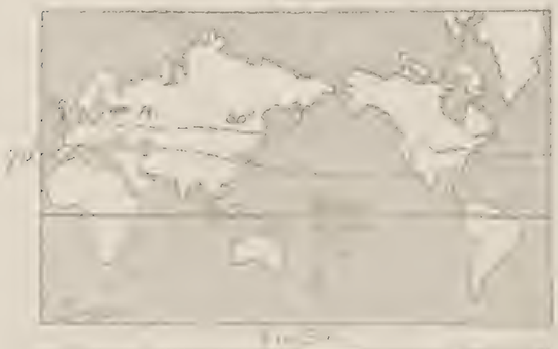

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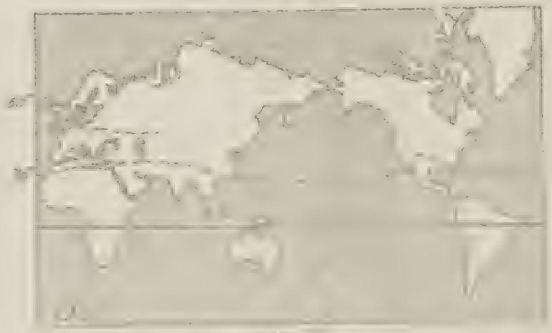

Fig. 35.

Fig. 36.

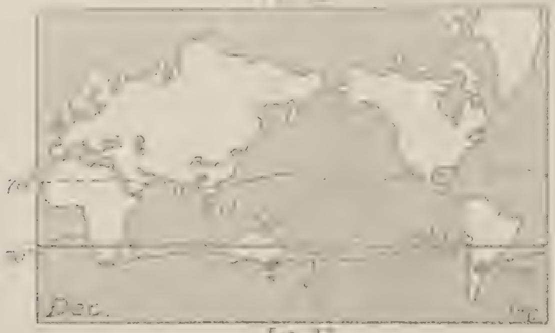

Fig. 37.

X.—THE WORLD'S WHEAT FIELDS.

35. In the twelve charts (Figs. 26–37) an attempt is made to show at a glance the climatic control of the world's harvests. Like all other seasonal phenomena, these depend on the annual march of the sun from the Tropic of Cancer in June to the Tropic of Capricorn in December, and back northward again by the following June.

On the twelve monthly charts the latitude of the overhead sun is shown (by a black line) and also the direction of its apparent movement. At the same time, the countries reaping wheat are shown as black areas; and also the approximate isothermal which passes through such wheat areas in that month.

The harvests are classified in relation to the sun's movements in the following table. It must be remembered that there is a time-lag of about two months in the maximum temperature behind the solstice. Thus, the sun is furthest south about 22nd December, but the hottest days in Australia are often in February:—

——	Approximate Harvest Temperature.	Southern Hemisphere.	Northern Hemisphere.
Harvest during increasing heat	70°	(August) none	February— South Egypt, South India
Spring	70°	(September) none	March— Egypt, Central India
	70° and 80°	(October) none	April— North Egypt, Asia Minor, North India, Mexico
	70° and 80°	November— Queensland, Cape Colony, North Argentine	May— Algeria, Central Asia, China, Japan, Texas
Summer	70° and 80°	December— New South Wales, Victoria, Argentine	June— Spain, Italy, Turkey, California, Utah, South-east States (U.S.A.)
	70°	January— Victoria, Tasmania, New Zealand (North Island), Chili	July— Germany, Austria, Roumania, South Russia, North U.S.A., East Canada
	70°	February— Tasmania, New Zealand (South Island)	August— England, Belgium, North Germany, Russia, Manitoba
Harvest during decreasing heat (Autumn)	60°	(March) none	September— Scotland, North Russia

It will be seen that all the noteworthy harvests occur during the six months of increasing temperature, *i.e.*, from March to August in the northern hemisphere, and during the corresponding period (September to February) in the southern hemisphere. Only a few countries, such as Upper Egypt, South India, Scotland, and North Russia have harvests at other seasons, and they are in no sense typical wheat lands.

Comparing Australian wheat areas with other more important northern lands, we see that northern United States of America corresponds to Victoria, southern United States of America to New South Wales, Algeria and Texas to Queensland, while we have no crop harvest in early spring to correspond to the large crops of northern India. It is obvious that if our wheat fields be extended into warmer regions in central Queensland the harvest may be expected in the early spring or thereabouts, and then analogous countries will be northern India and the warmest States of United States of America.

36. Wheat Climates in United States of America.

In the vast territory of the United States—which is almost exactly the same area as Australia—conditions of rainfall and temperature naturally vary greatly. Hence the conditions governing the growth of wheat depend very largely on geographical position. In Fig. 38, I show the various types of wheat as given by Rutter, who describes seven main varieties. He also shows the temperature during the wheat crop season in 1897 (April to September). While it is not possible to point to exactly analogous conditions in Australia, it is instructive to note the very varied conditions under which wheat grows in the United States of America.

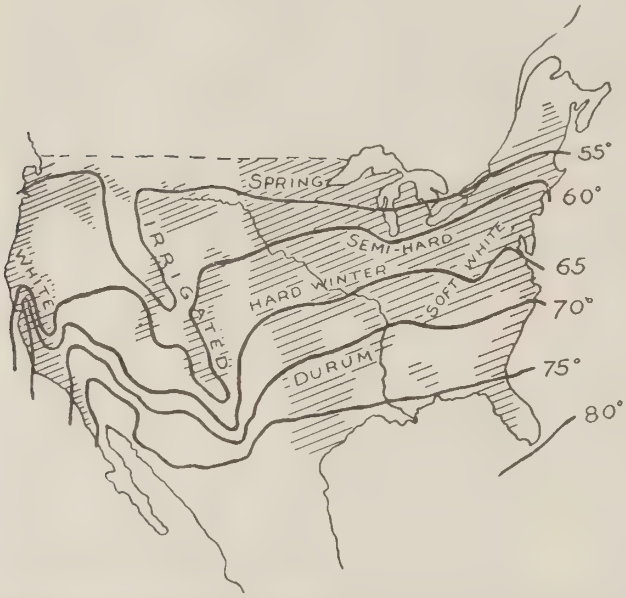

Fig. 38.—Chief Wheat Areas and Varieties, and Temperature, April–September (After Rutter). Hatched Areas grow over 7 bushels per acre (Gannett, 1900).

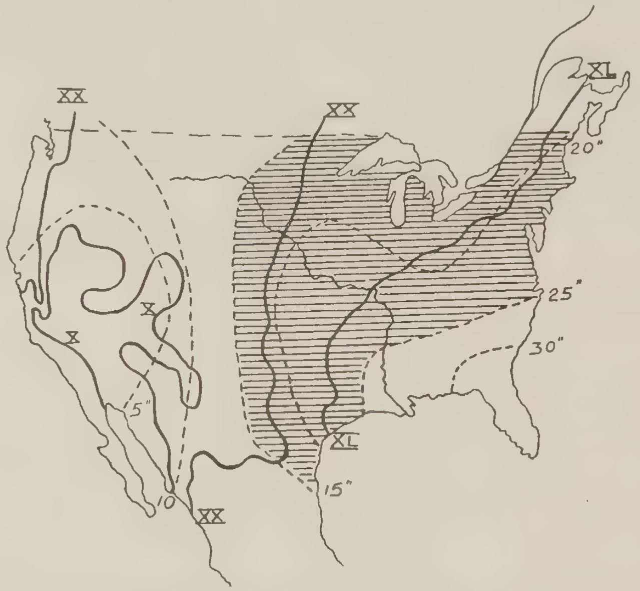

Fig. 39.—Average Annual Rainfall (thick lines) and approximate Average Rainfall for period April–September (broken lines).

In Fig. 39, I show the average annual rainfall lines and also the approximate rainfall during the same months, as used by Rutter. The area of greatest importance is hatched in Fig. 39 and is seen to be between the isohyets of 15 inches and 25 inches for Rutter's period, April to September.

The spring wheat of Minnesota requires only from 105 to 109 days to grow from seed to harvest, and four months suffices in most of northern United States of America. Hence April, May, June, July, and August are the important months, the harvest in the north being in late July or early August. It is thus allowable to compare Rutter's isotherms (Fig. 38) with those for Australia in Fig. 43, although the Australian data are for a somewhat longer period.

Comparative data for the United States of America wheat regions are given in the following table :—

Wheat.	Type State.	Approximate Rainfall.		Approximate Temperature.		Character, &c.
		Annual.	April–September.	Annual.	April–September.	
		Inches.	Inches.		*	
Soft Wheat	New England ..	40	20	53° F.	60° F.	Poor in gluten
Semi-hard	Indiana, &c. ..	40	20	53° F.	65° F.	Good
Hard Spring ..	Minnesota	25	18	44° F.	55° F.	Excellent
Hard Winter ..	Nebraska	20	18	50° F.	63° F.	Excellent
Durum	Texas	40	22	64° F.	72° F.	Macaroni wheat
Irrigated	Colorado	18	12	50° F.	60° F.	Soft, starchy

* After Rutter.

37. Wheat Climate in India.

It is a matter of considerable difficulty to obtain wheat data from India in the time at my disposal. I have mapped the wheat regions from Bartholomew's *Atlas of Commerce* in Fig. 40; and the more important of these are shown as dotted areas in Fig. 41. Lucknow and Lahore are approximately the chief centres, and their climates are shown in the following table, which gives other wheat centres also:—

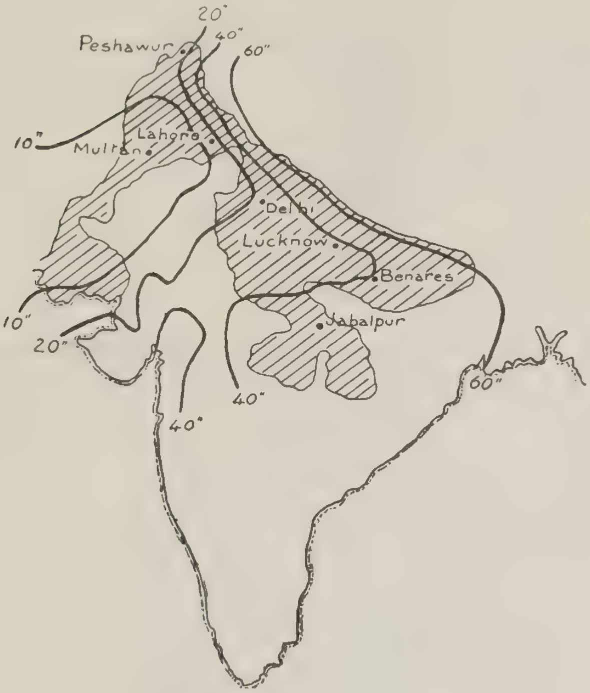

Fig. 40.—Chief Wheat Areas (showing 5 per cent. of all crops) and Annual Rainfall.

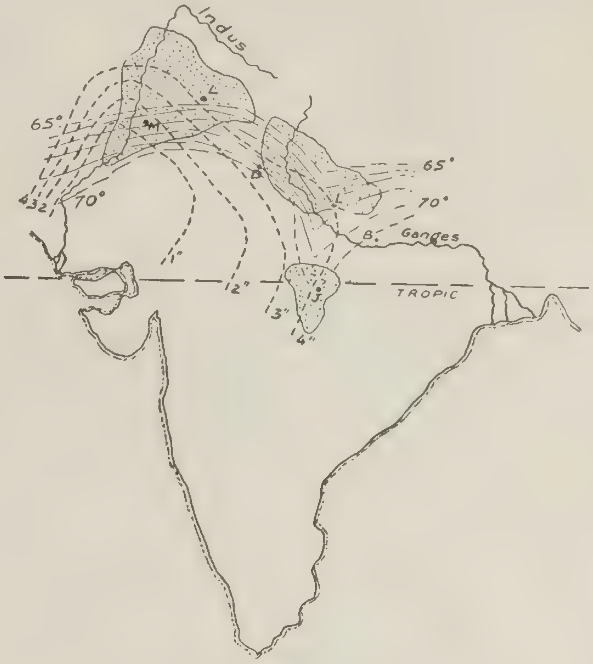

Fig. 41.—Most Important Wheat Areas (20 per cent. of all crops), showing approximate Rainfall and Temperature during growing season (October to April).

TEMPERATURE AND RAINFALL IN WHEAT AREAS.

—	Temperature.		Rainfall.	
	Annual.	October–April.	Annual.	October–April.
Lahore	75·9	64·8	19·3	3·7
Multan	78·7	67·6	6·5	2·0
Delhi	78·1	69·4	27·5	3·5
Lucknow	77·6	70·6	38·9	3·8
Benares	78·1	70·6	39·8	4·8
Jabalpur	76·4	70·4	55·7	4·0

It is at once obvious what a large part conservation and irrigation must play in Indian wheat culture. None of the above wheat districts has over 5 inches during the growing season (from October to April). Indeed, around Multan the total *annual* rainfall is only 6.5 inches, of which 2 inches fall during the growing period.

Rainfall conditions are, therefore, totally unlike any Australian regions so far interested in wheat. The annual rainfall varies from 6 inches at Multan to 56 inches at Jabalpur, instead of the fall being as in our wheat belt from 10 to 30 inches.

However, it is in the temperature factor that most interest lies for Australia. The chief Indian wheat areas have an average temperature of from 75° to 79° F.; while in the growing period the temperatures range from 64° to 71°. As we shall see, these latter temperatures are precisely those of Southern Queensland.

38. The Limits of Australian Wheat.

The following figures are given by Mr. Hunt for the various States as receiving 10 inches of rainfall or more during the wheat-growing period (April to October), and we have seen how closely this isohyet agrees with the wheat boundary :—

Western Australia	93,500	square miles.
South Australia	46,980	,, ,,
Queensland..	79 247	,, ,,
New South Wales	163,772	,, ,,
Victoria	74,616	,, ,,
Tasmania	26,215	, ,,
Total	484,330	,, ,,

I have calculated the wheat areas for the six States which are shown on the accompanying map. They are given in the following table, arranged in two series (which agree with the black and dotted areas respectively) :—

—	Areas with over 100 Bushels per Square Mile.	Areas with less than 100 Bushels.	Total.
	Square miles.	Square miles.	Square miles.
Western Australia	21,000	66,500	87,500
South Australia	43,000	30,100	73,100
Queensland	..	19,000*	19,000
New South Wales	55,700	70,000	125,700
Victoria	48,500	26,600	75,100
Tasmania	3,500	12,000	15,500
Total	171,700	224,200	395,900

* Only approximate, no exact data obtainable.

Of course it must be remembered that large areas in the second column grow very little wheat. My table is based on the returns per *county* or *division*, and many of the latter are not used to a quarter of their capacity. However, the first column shows the areas of important wheat culture, and the second shows areas where some wheat is being grown, and gives a useful approximation of the amount which can be ultimately used as valuable wheat areas. We notice that in Victoria and South Australia all the possible wheat counties are being cultivated to some extent for wheat. The figures derived from the rainfall table and from my maps closely agree. In New South Wales and Western Australia there are still virgin regions, but it is in Queensland that the future wheat increase may be expected.

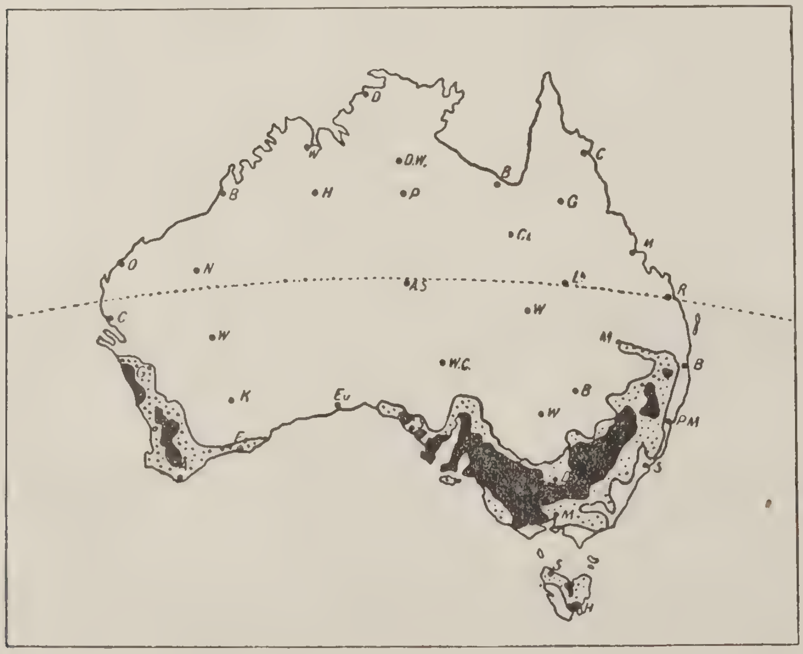

Fig. 42.—Wheat Distribution in 1912. Areas in black over 100 bushels per sq. mile.

In Fig. 43 will be found a map which I have prepared to show the average temperature in the wheat regions during the period April to October. The isotherms run approximately east and west, but curve around two cold areas in the south-west and south-east corners of the Continent respectively.

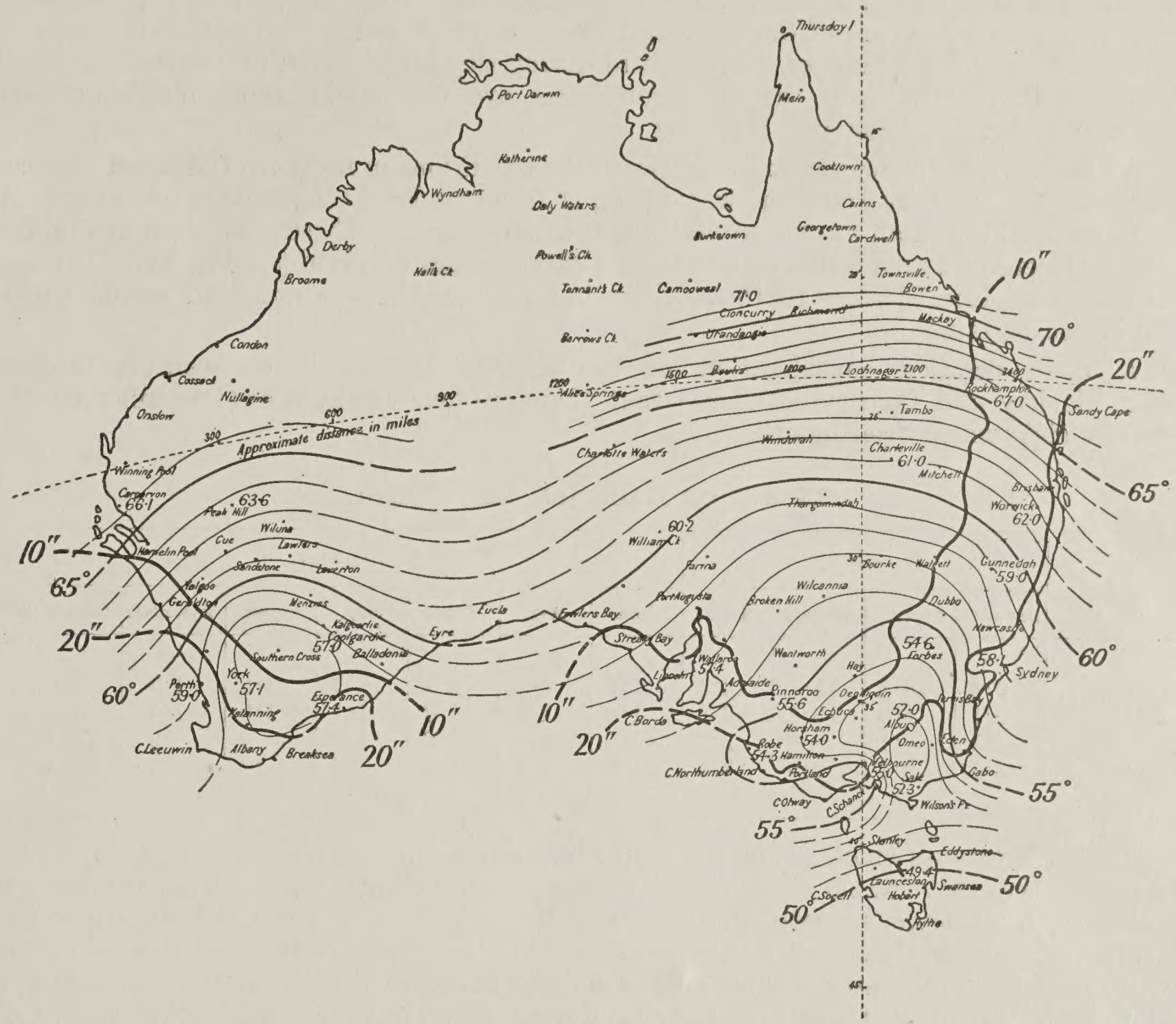

Fig. 43.—Approximate Isotherms for the wheat-growing period (April to October inclusive). The thick lines show the 10 and 20-inch Isohyets for the same period, and enclose the chief wheat regions. (Tropic of Capricorn and Longitude 145° are inserted).

With the aid of this map it is possible to tabulate the climatic controls governing wheat culture in the various States :—

Wheat Belt.	Temperature.			Rainfall.		
	Annual.	April–October.		Annual.	April–October.	
		Whole Area.	Best Area.		Whole Area.	Best Area.
				Inches.	Inches.	Inches.
Western Australia	70°–60°	63°–57°	62°–57°	40–10	30–10	20–15
South Australia	67°–58°	58°–54°	57°–55°	30–10	25–6	20–10
Queensland	68°–65°	62°–60°	..	40–23	20–10	..
New South Wales	67°–56°	61°–52°	61°–52°	45–14	25–9	15–11
Victoria	63°–55°	55°–52°	55°–52°	40–12	25–8	15–10
Tasmania	56°–50°	52°–46°	..	60–19	40–10	25–10

In the preceding sections I have drawn attention to the regions which are climatically suited for wheat, but are not yet exploited. These are the region north-east of Albany (in Western Australia), the northern portions of Eyre's Peninsula (in South Australia), the northern fringe of the wheat area of New South Wales from Coonamble to the Queensland border, and, finally, the south-east portion of Queensland. All except the latter region are normal extensions of well-known wheat areas.

Southern Queensland demands further consideration. In U.S.A. wheat is grown in Texas with an average temperature of 67° F. during the growing period from January to June. The annual rainfall is about 40 inches, and the rain during this same period (January–June) is about 24 inches. It will be seen that the conditions are not unlike those obtaining between Rockhampton and Brisbane (see Fig. 43).

A closer parallel, however, exists between the conditions in northern India and east-central Queensland. In northern India the wheat crop is grown under a temperature (October to April) of 65° F. to 71° F., and an annual rainfall of 20 to 50 inches. These conditions are fulfilled in the inland Queensland area south of Bowen and east of longitude 145° (see Fig. 43). The western half of this area—from Mackay to Charleville—has the same dry winter and spring with only 5 to 10 inches of rain.

A more detailed consideration of the seasonal rainfall in east-central Queensland (between Mackay and Charleville) shows that there are four wet months (December to March) followed by eight much drier months.

Inches of Rainfall, per Month.

—	Wet.				Dry.							
	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.
Mackay ..	6·6	13·8	11·7	13·1	7·0	4·0	2·7	1·7	1·0	1·9	2·0	2·9
Emerald ..	3·1	4·3	3·7	2·9	1·6	1·2	1·7	1·1	1·0	1·0	1·5	1·7
Tambo ..	2·1	3·1	3·0	2·7	1·5	1·8	1·2	1·2	·7	·9	1·3	1·6
Charleville ..	2·1	2·4	2·9	2·8	1·6	1·6	1·3	1·2	·7	·7	1·4	1·6

Taking Emerald (which lies on the tropic between Tambo and Mackay, Fig. 43) as typical of the region, the above table shows that it receives 14 inches of rain during the wet season. My colleague, Mr. Quayle, suggests that it would be advisable to follow the Indian practice and sow the wheat towards the end of the summer rains, *i.e.*, early in March. It would therefore have to depend for its water supply mainly on the moisture already in the soil. The wheat would probably ripen in about four months, during which it would receive an additional five inches of rainfall.

In general, the resemblance between the climates of east-central Queensland and the region around Delhi and Lucknow is sufficiently close to warrant a careful study of wheat culture in the northern granary. Varieties such as *durum*, differing from those usually grown in Australia, would seem to be indicated. It is in the hope that some agricultural expert will carry on the study that I have written these concluding sections.

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